

NOTICE

All drawings located at the end of the document.

**SURFACE WATER INTERIM MEASURES/
INTERIM REMEDIAL ACTION PLAN/
ENVIRONMENTAL ASSESSMENT
AND DECISION DOCUMENT**

**903 PAD, MOUND, AND
EAST TRENCHES AREAS**

OPERABLE UNIT NO. 2

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

12 June 1990

Volume I - Text

DRAFT

ADMIN RECORD

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OPERABLE UNIT 2

ROCKY FLATS PLANT
GOLDEN, COLORADO

12 JUNE 1990

DRAFT

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EXECUTIVE SUMMARY

In February and March 1990, representatives from the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Colorado Department of Health (CDH) met to discuss interim cleanup actions at the Rocky Flats Plant site. The results of these meetings produced a series of agreements, with the concurrence of all parties, to implement an interim remedial action for the cleanup of surface water contaminants in the area designated as Operable Unit No. 2. The plans for the cleanup of contaminated surface water produced an agreement (1) on the specific point source locations for the collection of surface water and (2) that interim actions were to be designed to address cleanup of base flow rates of water, and are not to be designed to capture and treat all waters potentially flowing from the sources. On these bases, the DOE has proceeded to develop a surface water collection and treatment system to meet the requirements set forth in this three party agreement.

The Rocky Flats Plant (RFP) is located approximately 16 miles northwest of downtown Denver, Colorado on 6,550 acres of Federally owned land in Jefferson County. The area of the plant buildings, confined to a much smaller area (approximately 400 acres), is the focal point for this interim action. The specific area, known as Operable Unit No. 2, is comprised of the 903 Pad, Mound, and East Trenches areas.

This Interim Measures/Interim Remedial Action (IM/IRA) will be conducted in accordance with the Resource Conservation and Recovery Act of 1976 (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA), the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Environmental Policy Act (NEPA) of 1969. Further, pursuant to the Agreement in Principle between the DOE, CDH and the EPA, it was agreed that DOE would initiate surface water cleanup within Operable Unit No. 2 as soon as the regulatory process would allow.

EG&G has prepared this Interim Remedial Action Plan/Environmental Assessment (IRAP/EA) to identify and evaluate surface water collection and treatment alternatives. Based on the evaluations, a preferred surface water collection and treatment system is recommended.

Background water quality characteristics were determined through an evaluation of existing water quality data. This analysis included evaluation of data collected for surface and ground water samples. Contaminants identified in individual sampling locations included volatile organic and inorganic constituents (i.e. metals, radionuclides and major ions).

Having identified the extent of the contamination within Operable Unit No. 2, this report next focuses on the containment, reduction, and/or elimination of site contaminants identified as posing a threat to human health or the environment. This is accomplished by an evaluation of alternative collection systems that examine both collection at the surface water source as well as collection at downgradient retention ponds. The screening process evaluates the effectiveness, implementability, and costs of each alternative. Collection of surface water at the source was selected as the preferred collection system as it minimized the amount of water treatment necessary as well as reduced the potential for further, downgradient contamination. The latter would be possible through percolation of contaminated surface water through downgradient soils and release of volatile contaminants to the atmosphere.

Screening of surface water treatment technologies includes evaluation of suspended solids, radionuclide and organic contaminant removal. Each alternative was evaluated for effectiveness, implementability, and cost of each alternative. The advanced membrane filtration system together with an activated carbon adsorption system is selected as the preferred alternative.

The remainder of this IRAP/EA addresses the specific environmental and health risks associated with each of the alternatives, including the preferred alternative, for the proposed action in accordance with the requirements of NEPA. The results of this evaluation illustrates that the impact of each of the possible alternatives is minimal, with the exception of the No Action Alternative, compared to the ongoing operations at the Rocky Flats Plant. Impacts to air and water quality, land, and short- and long-term land productivity as well as exposure to personnel are minimal compared to the benefits of cleaning up the surface waters of the area.

SECTION 1.0

INTRODUCTION

1.1 BACKGROUND

The Department of Energy (DOE) wishes to pursue an interim remedial action for surface water at the 903 Pad, Mound and East Trenches Areas, now termed Operable Unit No. 2 at the Rocky Flats Plant (RFP). In accordance with the Resource Conservation and Recovery Act of 1976 (RCRA) as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA), and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), this Interim Measures/Interim Remedial Action (IM/IRA) will be conducted to minimize the migration of hazardous substances via surface water from areas that pose a potential long-term threat to the public health and environment. DOE is implementing this IM/IRA Plan because of the length of time it typically takes to finalize a RCRA Facility Investigation/Remedial Investigation (RFI/RI), and Corrective Measures Study/Feasibility Study (CMS/FS).

Organic and inorganic contamination of surface water has resulted from past operational practices no longer permitted under current regulations. The sources of the contamination are, in part, within Operable Unit No. 2. There is no immediate threat to public health and the environment posed by surface water contamination because the affected surface water is contained within the plant boundary. However, an unacceptable risk could be posed to the public should this contamination be released downgradient beyond the plant boundary.

EG&G has prepared this IM/IRA Plan to identify, screen, and evaluate appropriate interim remedial action alternatives, and select the preferred interim remedial action for the contaminated surface water. This IM/IRA Plan has been prepared to conform with the requirements for an Engineering Evaluation/Cost Analysis (EE/CA) as defined in the proposed National Contingency Plan [40 CFR 300.415(b)(4)]. It also conforms to the National Environmental Policy Act (NEPA) of 1969, as implemented by regulations promulgated by the President's Council on Environmental Quality (40 CFR 1500-1508), and DOE Guidelines (10 CFR 1021, DOE Order 5440.1c and 5400.4, DOE/EV-0132).

In March 1987, a Phase I remedial investigation under the Environmental Restoration (ER) Program [formerly known as the Comprehensive Environmental Assessment and Response Program (CEARP)] began at Operable Unit 2. The investigation consisted of the preparation of detailed topographic maps, radiometric and organic vapor screening surveys, surface geophysical surveys, a soil gas survey, a boring and well completion program, soil sampling and ground and surface water sampling. Phase I field activities were completed at Operable Unit 2 during 1987, and a draft RI report was submitted to EPA and CDH on December 31, 1987 (Rockwell International, 1987a). Phase I data did not allow adequate definition of the nature and extent of contamination for the purpose of conducting a feasibility study of remedial alternatives pertaining to contaminated media. A Phase II RI Sampling Plan that presents the details and rationale for further field work to achieve this objective was submitted to the regulatory agencies in June 1988 (Rockwell International, 1988a).

A draft IM/IRA plan for contaminated ground water at Operable Unit No. 2 was submitted in December 1989 (Rockwell International, 1989). Regulatory agency review of the document indicated that, although an IM/IRA for ground water is required by the Agreement in Principle, insufficient information on the nature and extent of ground water contamination exists at this time to pursue ground water remediation. In order to facilitate early evaluation on the need for an IM/IRA for ground water at Operable Unit No. 2, a final RFI/RIFS sampling plan that incorporates a phased investigation approach was submitted to the regulatory agencies in April 1990 (EG&G, 1990). The phased approach is to investigate alluvial and bedrock migration pathways first, and then to subsequently investigate ground-water contaminant sources. This will allow planning, design, and implementation of a ground-water IM/IRA before completion of the RFI/RI and CMS/FS for Operable Unit 2, if required.

As mentioned above, this document describes the proposed IM/IRA for Operable Unit No. 2 Surface Water. Not described in this document, however, is the phase of work which is intended to allow a 1990 startup of the IM/IRA. This is to be achieved by the installation of a mobile field treatability test unit which will initially treat only surface water collected from surface water monitoring station SW-61 (i.e. South Walnut Creek). This field treatability unit will provide the initial treatment capacity of the proposed IM/IRA facility described in Section 6.0. The field treatability study will involve installation of granular activated carbon advanced microfiltration system, and ion exchange (if bench scale tests indicated feasibility) test units. The

carbon adsorption units would be installed first (operational in 1990) followed by installation of the microfiltration and ion exchange units in one to two month intervals after installation of the carbon adsorption units.

1.2 IM/IRA PLAN ORGANIZATION

Section 2.0 (Site Characterization) of this plan describes the potentially affected environment associated with the proposed IM/IRA, and the results of the previous investigation at Operable Unit 2. Most of the information included in Section 2.0 has been derived from the draft RI report and final Phase II Sampling Plan.

Section 3.0 identifies the objectives of the IM/IRA, applicable or relevant and appropriate requirements (ARARs), and applicable environmental regulations. The objectives and ARARs define the criteria used to identify and evaluate IM/IRA options.

Section 4.0 identifies technically feasible IM/IRA alternatives that address the objectives, and screens these alternatives based on implementability, effectiveness, and costs.

Section 5.0 summarizes the detailed analysis performed in Section 4.0, and Section 6.0 presents the preferred IM/IRA.

Sections 7.0 and 8.0 incorporate NEPA documentation regarding the environmental effects of the preferred IM/IRA and other IM/IRA alternatives, respectively. This analysis is intended to provide sufficient information to aid in a NEPA determination of environmental impacts of the proposed interim remedial action. The scope of the analysis does not include evaluation of the existing operations at the Rocky Flats Plant, final remedial actions at Operable Unit 2 or subsequent remedial actions at other locations of the Rocky Flats Plant. The environmental impacts of plant operation were previously analyzed in the final Environmental Impact Statement (DOE, 1980). NEPA documentation for final remedial actions at Operable Unit 2 and any subsequent remedial actions at other locations of the Rocky Flats Plant will be provided in future documents.

Volume II of this IM/IRA Plan contains the surface water quality data for Operable Unit 2.

SECTION 2.0

SITE CHARACTERIZATION

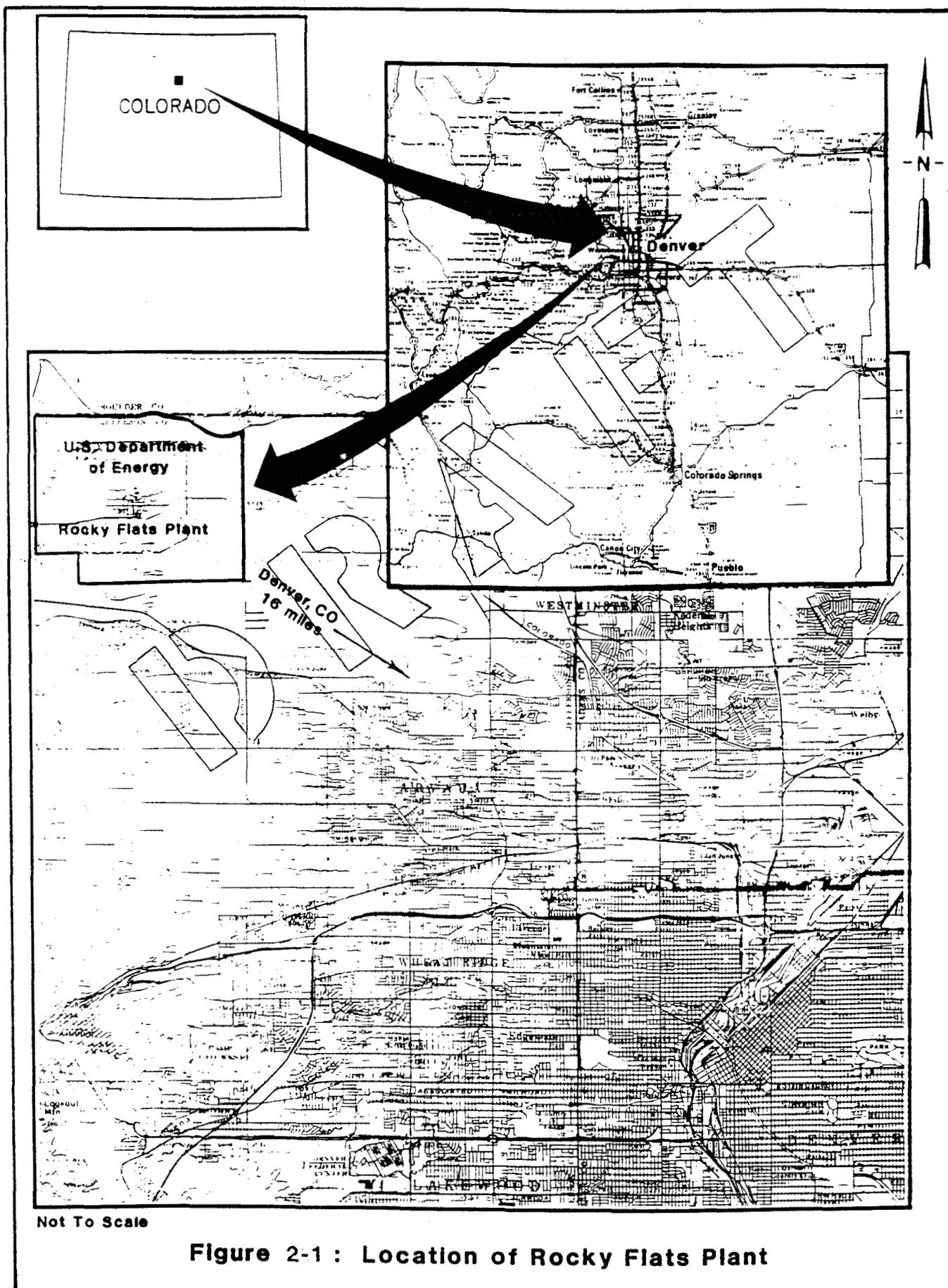
2.1 SITE DESCRIPTION AND BACKGROUND

2.1.1 Location and Facility Type

The Rocky Flats Plant (RFP) is located in northern Jefferson County, Colorado, approximately 16 miles northwest of downtown Denver (Figure 2-1). The Plant site consists of approximately 6,550 acres of federally-owned land in Sections 1 through 4, and 9 through 15, of T2S, R70W, 6th principal meridian. Plant buildings are located within an area of approximately 400 acres, known as RFP security area. The security area is surrounded by a buffer zone of approximately 6,150 acres.

The RFP is a government-owned, contractor-operated (GOCO) facility. It is part of a nationwide nuclear weapons research, development, and production complex administered by the Rocky Flats Operations Office of the U.S. Department of Energy. The operating contractor for the Rocky Flats Plant is EG&G. The facility manufactures components for nuclear weapons and has been in operation since 1951. RFP fabricates components from plutonium, uranium, beryllium, and stainless steel. Production activities include metal fabrication, machining, and assembly. Both radioactive and nonradioactive wastes are generated in the process. Current waste handling practices involve on-site and off-site recycling of hazardous materials and off-site disposal of solid radioactive materials at another DOE facility.

The RFP is currently an interim status Resource Conservation and Recovery Act (RCRA) hazardous waste treatment/storage facility. In the past, both storage and disposal of hazardous and radioactive wastes occurred at on-site locations. Preliminary assessments conducted under Phase 1 of the ER Program identified some of the past on-site storage and disposal locations as potential sources of environmental contamination.



2.1.2 Operable Unit 2 Description

There are 20 sites designated as solid waste management units (SWMUs) which comprise the 903 Pad, Mound and East Trench Areas. These sites are known collectively as Operable Unit 2, and are located east-southeast of the RFP (Figure 2-2).

2.1.2.1 903 Pad Area

Five sites are located within the 903 Pad Area (Figure 2-2). These sites are:

- 903 Drum Storage Site (SWMU Ref. No. 112);
- 903 Lip Site (SWMU Ref. No. 155);
- Trench T-2 Site (SWMU Ref. No. 109);
- Reactive Metal Destruction Site (SWMU Ref. No. 140); and
- Gas Detoxification Site (SWMU Ref. No. 183).

Presented below are brief descriptions of each of these sites.

1. **903 Drum Storage Site (SWMU Ref. No. 112)** -- The site was used from 1958 to 1967 to store drums containing radioactively contaminated used machine cutting oil. The drums, some of which corroded and leaked, contained oils and solvents contaminated with plutonium or uranium. Most of the drums contained lathe coolant consisting of mineral oil and carbon tetrachloride (CCl_4) in varying proportions. However, an unknown number of drums contained hydraulic oils, vacuum pump oils, trichloroethene (TCE), tetrachloroethene (PCE), silicone oils, and acetone (Rockwell International, 1987a). Ethanolamine was also added to new drums after 1959 to reduce the drum corrosion rate. All drums were removed by 1968.

After the drums were removed, efforts were undertaken to scrape and move the plutonium-contaminated soil into a relatively small area, cover it with fill material, and top it with an asphalt containment cover. This remedial action was completed in November 1969. An estimated 5,000 gallons of liquid leaked into the soil during use of the drum storage site. The liquid was estimated to contain 86 grams of plutonium (Rockwell International, 1987a).
2. **903 Lip Site (SWMU Ref. No. 155)** -- During drum removal and cleanup activities associated with the 903 Drum Storage Site, winds distributed plutonium beyond the pad to the south and east. Although some plutonium-contaminated soils were removed, radioactive contamination is still present at the 903 Lip Site in the surficial soils.
3. **Trench T-2 Site (SWMU Ref. No. 109)** -- This trench was used prior to 1968 for the disposal of sanitary sewage sludge and flattened drums contaminated with uranium and plutonium.
4. **Reactive Metal Destruction Site (SWMU Ref. No. 140)** -- This site was used during the 1950s and 1960s primarily for the destruction of lithium metal (DOE, 1986). Small quantities of other reactive metals (sodium, calcium, and magnesium) and some solvents were also destroyed at this location (Illsley, 1978).

5. **Gas Detoxification Site (SWMU 183)** -- Building 952, located south of the 903 Drum Storage Site, was used to detoxify various bottled gases between June 1982 and August 1983.

2.1.2.2 Mound Area

The Mound Area is composed of four sites (Figure 2-2). These are:

- Mound Site (SWMU Ref. No. 113);
- Trench T-1 Site (SWMU Ref. No. 108);
- Oil Burn Pit No. 2 Site (SWMU Ref. No. 153); and
- Pallet Burn Site (SWMU Ref. No. 154).

These sites are described individually below.

1. **Mound Site (SWMU Ref. No. 113)** -- The Mound Site contained approximately 1,405 drums containing primarily depleted uranium and plutonium contaminated lathe coolant. Some drums also contained "Perclene" (Smith, 1975). Perclene was a brand name of tetrachloroethene (Sax and Lewis, 1987). Some of the drummed wastes placed in the Mound Site were in solid form (Rockwell International, 1987b). Cleanup of the Mound Site was accomplished in 1970, and the materials removed were packaged and shipped to an off-site DOE facility as radioactive waste. Subsequent surficial soils sampling in the vicinity of the excavated Mound Site indicated 0.8 to 112.5 disintegrations per minute per gram (d/m/g) alpha activity. This radioactive contamination is thought to have come from the 903 Drum Storage Site via wind dispersion rather than from the Mound Site (Rockwell International, 1987a).
2. **Trench T-1 Site (SWMU Ref. No. 108)** -- The trench was used from 1954 until 1962 and contains approximately 125 drums filled with depleted uranium chips (Dow Chemical, 1971) and plutonium chips coated with lathe coolant. The drums are still present in this trench.
3. **Oil Burn Pit No. 2 Site (SWMU Ref. No. 153)** -- Oil Burn Pit No. 2 is actually two parallel trenches which were used in 1957 and from 1961 to 1965 to burn 1,082 drums of oil containing uranium (Rockwell International, 1987b). The residues from the burning operations and some flattened drums were covered with backfill. Cleanup operations were performed in the 1970s (Rockwell International, 1987a).
4. **Pallet Burn Site (SWMU Ref. No. 154)** -- An area southwest of Oil Burn Pit No. 2 was reportedly used to destroy wooden pallets in 1965. The types of hazardous substances or radionuclides that may have been spilled on these pallets is unknown. Clean-up actions were performed in the 1970s (DOE, 1986).

2.1.2.3 East Trenches Area

The East Trenches Area consists of nine burial trenches and two spray irrigation areas (Figure 2-2). The trench numbers and their respective SWMU designations are:

Trench T-3 -- SWMU Ref. No. 110
Trench T-4 -- SWMU Ref. No. 111.1
Trench T-5 -- SWMU Ref. No. 111.2
Trench T-6 -- SWMU Ref. No. 111.3
Trench T-7 -- SWMU Ref. No. 111.4
Trench T-8 -- SWMU Ref. No. 111.5
Trench T-9 -- SWMU Ref. No. 111.6
Trench T-10 -- SWMU Ref. No. 111.7
Trench T-11 -- SWMU Ref. No. 111.8

Trenches T-3, T-4, T-10, and T-11 are located north of the east access road, and trenches T-5 through T-9 are located south of the east access road. The trenches were used from 1954 to 1968 for disposal of depleted uranium, flattened depleted uranium and plutonium-contaminated drums, and sanitary sewage sludge. The wastes have not been disturbed since their burial.

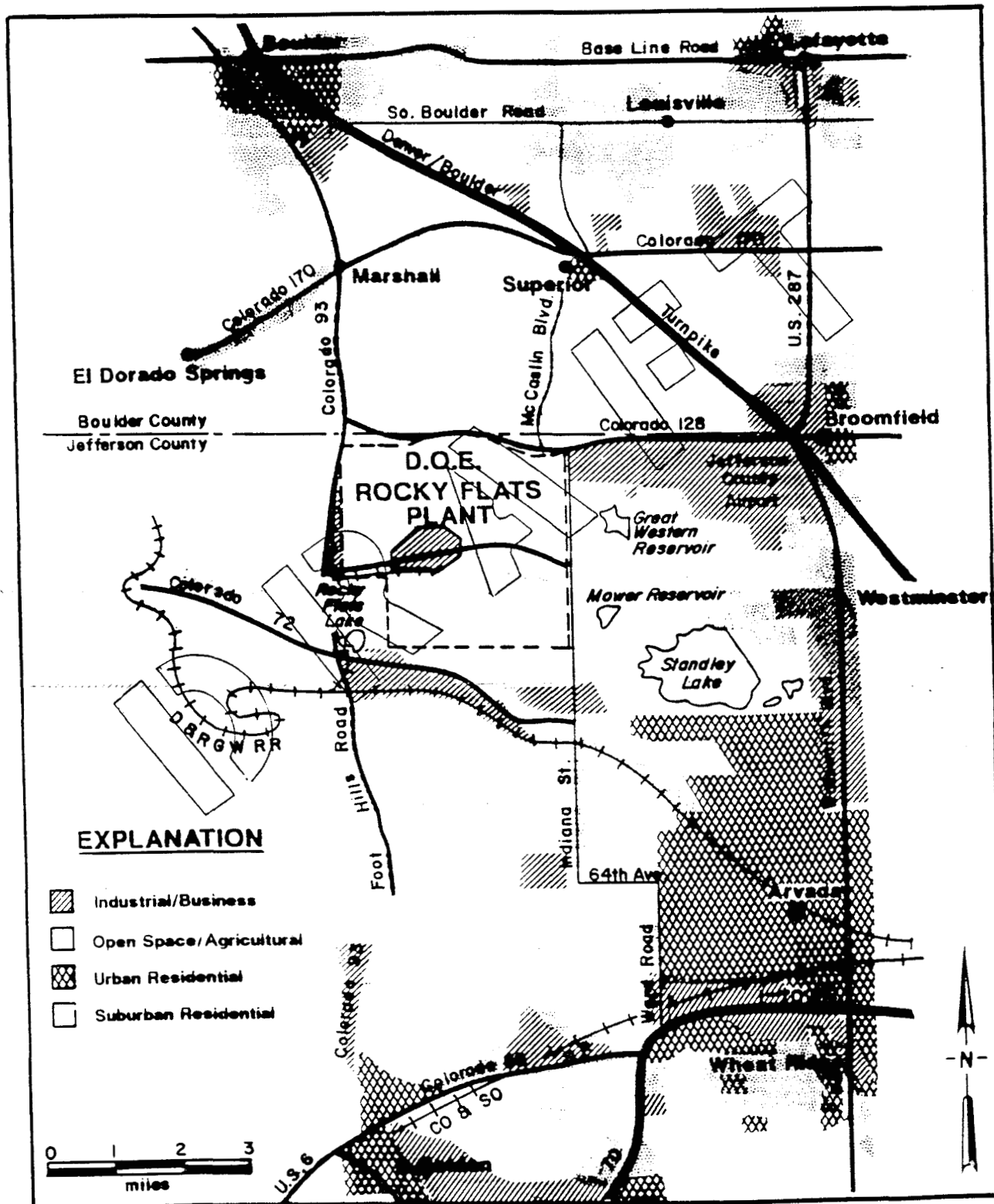
SWMU numbers 216.2 and 216.3 were used for spray irrigation of sewage treatment plant effluent. These areas have been designated as solid waste management units because of the potential for chromium contamination that resulted from a Plant spill of chromic acid that entered the sanitary sewers on February 23, 1989. Based on results of sampling after the February spill, leachable chromium concentrations in soils were significantly below the RCRA Extraction Procedure (EP) Toxicity limits (Rockwell International, 1989a).

2.1.3 Surrounding Land Use and Population Density

The Rocky Flats Plant is located in a rural area (Figure 2-3). Approximately 50 percent of the area within ten miles of the Rocky Flats Plant is in Jefferson County. The remainder is located in Boulder County (40 percent) and Adams County (10 percent). According to the 1973 Colorado Land Use Map, 75 percent of this land was unused or was used for agriculture. Since that time, portions of this land have been converted to housing, with several new housing subdivisions being started within a few miles of the buffer zone.

A demographic study using 1980 census data shows that approximately 1.8 million people lived within 50 miles of the Rocky Flats Plant in 1980 (Rockwell International, 1987b). Approximately 9,500 people lived within five miles of the Plant in 1980. The most populous sector was to the southeast, toward the center of Denver. This sector had a 1980 population of about 555,000 people living between 10 and 50 miles from Rocky Flats. Recent population estimates registered by the Denver Regional Council of Governments (DRCOG) for the eight county Denver metro region have shown distinct patterns of growth between the first and second halves of the decade. Between 1980 and 1985, the population of the eight county region increased by 197,890, a 2.4 percent annual growth rate. Between 1985 and 1989 a population gain of 71,575 was recorded, representing a 1.0 percent annual increase (the national average). The 1989 population showed an increase of 2,225 (or 0.1 percent) from the same date in 1988 (DRCOG, 1989).

There are eight public schools, within six miles of the Rocky Flats Plant. The nearest educational facility is the Witt Elementary School, which is approximately 2.7 miles east of the Plant buffer zone. The closest hospital is Centennial Peaks Hospital located approximately seven miles northeast. The closest park and recreational area is the Standley Lake area, which is approximately five miles southeast of the Plant. Boating, picnicking, and limited overnight camping are permitted. Several other small parks exist in communities within ten miles. The closest major park, Golden Gate Canyon State Park, located approximately 15 miles to the southwest, provides 8,400 acres of general camping and outdoor recreation. Other national and state parks are located in the mountains west of the Rocky Flats Plant, but all are more than 15 miles away.



(after: Rockwell International, 1986a)

Figure 2-3:
LAND USE IN THE VICINITY OF ROCKY FLATS PLANT

Some of the land adjacent to the Plant is zoned for industrial development. Industrial facilities within five miles include the TOSCO laboratory (40-acre site located two miles south), the Great Western Inorganics Plant (two miles south), the Frontier Forest Products yard (two miles south), the Idealite Lightweight Aggregate Plant (2.4 miles northwest), and the Jefferson County Airport and Industrial Park (990-acre site located 4.8 miles northeast).

Several ranches are located within ten miles of the Plant, primarily in Jefferson and Boulder Counties. They are operated to produce crops, raise beef cattle, supply milk, and breed and train horses. According to the 1987 Colorado Agricultural Statistics, 20,758 acres of crops were planted in Jefferson County (total land area of approximately 475,000 acres) and 68,760 acres of crops were planted in Boulder County (total land area of 405,760 acres). Crops consisted of winter wheat, corn, barley, dry beans, sugar beets, hay, and oats. Livestock consisted of 5,314 head of cattle, 113 hogs, and 346 sheep in Jefferson County, and 19,578 head of cattle, 2,216 hogs, and 12,133 sheep in Boulder County (Post, 1989).

2.2 AFFECTED AND SENSITIVE ENVIRONMENT

2.2.1 Physical Environment

The natural environment of the Plant and vicinity is influenced primarily by its proximity to the Front Range of the Rocky Mountains. The Plant is directly east of the north-south trending Rocky Mountains, with an elevation of approximately 6,000 feet above sea level. Rocky Flats Plant is located on a broad, eastward sloping plain of overlapping alluvial fans developed along the Front Range. The fans extend about five miles in an eastward direction from their origin in the abruptly rising Front Range and terminate on the east at a break in slope to low rolling hills. The continental divide is about 16 miles west of the Plant. The operational area at the Plant is located near the eastern edge of the fans on a terrace between stream-cut valleys (North Walnut Creek and Woman Creek). The Rocky Flats Alluvium (the deposit of coalescing alluvial fans) is exposed at the surface and consists of a topsoil layer underlain by as much as 100 feet of silt, clay, sand, and gravel.

The Rocky Flats Plant is situated in a semiarid region, averaging 15 inches of annual precipitation. Forty percent of the yearly total comes in the spring, much of it in the form of snow. Of the balance, 30 percent is accounted for by summer thunderstorms, with the rest falling in the fall (11%) and winter months (19%). Average yearly snowfall averages 85 inches. Runoff control structures exist to channel surface water from the Plant to monitoring ponds. These structures are sized to accommodate the 100-year storm event which is equivalent to four inches of rain in a six hour period.

Mineral resources occurring in the vicinity of RFP include sand, gravel, crushed rock, clay, coal, and uranium. There are no known clay, coal or uranium deposits within the RFP buffer zone, however, these commodities are mined in the region, within 20 miles of the plant. The Schwartzwalder Uranium Mine is located approximately four miles southwest of RFP. The mine has been the largest producer of vein type uranium ore in Colorado and ranks among the six largest of this type in the United States (DOE, 1980). Active sand and gravel mines lie within the buffer zone boundaries. There is a currently inactive aggregate processing facility adjacent to the northwest corner of the buffer zone which is scheduled to be reopened in 1989. Oil and natural gas production is also active in nearby northwest Adams County and east central Boulder County.

There are four main drainages from the plant property as shown on Figure 2-4: North Walnut, South Walnut, Rock and Woman Creeks. All are intermittent streams which provide drinking water and irrigation water. There are a number of ditches crossing the area as well, conveying water collected off-site to other areas, the Plant, Walnut Creek, or Woman Creek. Until late 1974, plant waste water had been discharged to Walnut Creek, and until 1975, filter backwash from the raw water treatment plant went into Woman Creek. All process waste water is now either recycled or disposed of through evaporation. Sanitary waste water is discharged in accordance with the NPDES permit effluent limitations when on-site spray irrigation is not feasible.

2.2.2 Operable Unit 2 Geology

The following geologic information is based on Rockwell International's Draft RI Report, and the reader is referred to this report for additional details (Rockwell International, 1987a).

2.2.2.1 Surficial Materials

Surficial materials at the 903 Pad, Mound, and East Trench Areas consist of the Rocky Flats Alluvium, colluvium, and valley fill alluvium uncomfortably overlying bedrock. All of the study areas are situated on a terrace of Rocky Flats Alluvium that extends eastward from the Plant. The Rocky Flats Alluvium consists of a poorly to moderately sorted, poorly stratified, deposit of clays, silts, sands, gravels, and cobbles. A portion of the 903 Pad Area extends south off the terrace toward the South Interceptor Ditch. Colluvium is present on the hillside south of the 903 Pad and East Trenches Area and in the South Walnut Creek drainage north of the Mound Area.

2.2.2.2 Bedrock Materials

The Cretaceous Arapahoe Formation underlies surficial materials at the 903 Pad, Mound, and East Trenches Areas. Sixteen wells were completed in various zones within the bedrock during the 1987 drilling program. The Arapahoe Formation consists of fluvial claystones with interbedded lenticular sandstones, siltstones, and occasional lignite deposits. Contacts between these lithologies are both gradational and sharp.

Claystone was the most frequently encountered lithology of the Arapahoe Formation immediately below the alluvium/bedrock contact. Weathered bedrock was encountered directly beneath surficial materials in all of the boreholes and wells. Many of the wells completed in shallow and deep sandstones indicate saturated conditions.

2.2.3 Site Hydrology

2.2.3.1 Surface Water

Surface water drainage patterns at the Rocky Flats Plant are shown on Figures 2-2 and 2-4. A discussion of the major surface water features is presented below.

South Walnut Creek

The headwaters area of South Walnut Creek has been filled during construction of plant facilities. As a result, flow originates from a buried culvert located west of Building 991 (see Figure 2-2). Flow in the upper reach of South Walnut Creek is routed beneath Building 991 in a corrugated metal pipe. The discharge from the corrugated metal pipe is augmented by flow from a concrete pipe at a point north of the Mound Area. The flow from the concrete pipe originates as seepage from the hillside south of Building 991 and flows into a ditch along the slope. The combined flow then enters the South Walnut Creek retention pond system. Below the retention ponds, South Walnut Creek, North Walnut Creek, and an unnamed tributary join within the buffer zone before flowing into Great Western Reservoir. Great Western Reservoir is located approximately one mile east of this confluence.

The South Walnut Creek retention pond system consists of five ponds (B-1, B-2, B-3, B-4, and B-5) that retain surface water runoff, and Plant discharges for the purpose of monitoring before downstream release of these waters. All flow in the pond system is eventually retained in Pond B-5 where it is monitored for quality before discharge in accordance with the Plant's National Pollutant Discharge Elimination System (NPDES) permit (discharge point 006). Ponds B-1 and B-2 are reserved for spill control, surface water runoff, or treated sanitary waste of questionable quality. Pond B-3 is used as a holding pond for sanitary sewage treatment plant effluent. The normal discharge of Pond B-3 is to a spray system located in the vicinity of the East Trenches. Ponds B-4 and B-5 receive surface water runoff from the central portion of the Plant, and occasional discharges from Pond B-3. The surface water runoff received by Pond B-4 is collected by the Central Avenue Ditch and upper reaches of South Walnut Creek.

Woman Creek

Woman Creek is located south of the Plant with headwaters in largely undisturbed Rocky Flats Alluvium. Runoff from the southern part of the Plant is collected in the South Interceptor Ditch located north of the creek and delivered downstream to Pond C-2 (see Figure 2-2). Pond C-1 (upstream of C-2) receives stream flow from

Woman Creek. The discharge from Pond C-1 is diverted around Pond C-2 into the Woman Creek channel downstream. Water in Pond C-2 is discharged to Woman Creek in accordance with the Plant NPDES permit (discharge point 007).

Flow in Woman Creek and the South Interceptor Ditch is intermittent. During the 1986 and 1987 investigations, there was no visible surface flow in Woman Creek downstream of Pond C-2. The intermittent surface water flow observed for Woman Creek and the South Interceptor Ditch is indicative of frequent interaction with the shallow ground-water system.

2.2.3.2 Ground Water

Ground water occurs in surficial materials (Rocky Flats Alluvium, colluvium, and valley fill alluvium,) and in Arapahoe sandstones and claystones at Operable Unit 2. These two hydraulically connected flow systems are discussed separately below.

Ground Water in Surficial Materials

Ground water is present in the Rocky Flats Alluvium, colluvium, and valley fill alluvium under unconfined conditions. Recharge to the water table occurs as infiltration of incident precipitation and as seepage from ditches and creeks. In addition, retention ponds along South Walnut Creek and Woman Creek recharge the valley fill alluvium. Figure 2-5 presents the potentiometric surface of uppermost ground water measured on December 1, 1987, and the locations of alluvial and bedrock wells in the vicinity of Operable Unit 2.

The shallow ground-water flow system is quite dynamic, with large water level changes occurring in response to precipitation events and stream and ditch flow. For example, between mid-April and September, 1986, water levels in wells 1-86 and 4-86 (completed in valley fill alluvium) dropped more than four and eight feet, respectively. Alluvial water levels are highest during the months of May and June. Water levels decline during late summer and fall, and some wells go completely dry at this time of year. Ground-water flow in the Rocky Flats Alluvium is generally from west to east following the buried topography on top of claystone bedrock.

Alluvial ground water discharges to seeps, springs, surface water drainages, and subcropping Arapahoe sandstone at Operable Unit 2. Seeps and springs occur along the edge of the Rocky Flats Alluvium terrace (at the alluvium/bedrock contact) and on the side slopes of the terrace. Seeps and springs on the terrace side slopes may be due to thinning of colluvial materials. Ground water in colluvial materials south of the 903 Pad and East Trenches Areas discharges to the South Interceptor Ditch, and ground water in valley fill materials discharges to Woman or South Walnut Creeks.

Hydraulic conductivity values were developed for surficial materials from drawdown-recovery tests performed on 1986 wells during the initial site characterization and from slug tests performed on select 1986 and 1987 wells during the 1987 Phase I RI (Rockwell International, 1987a). The average ground-water velocities in the Rocky Flats Alluvium, Woman Creek Valley fill alluvium, and South Walnut Creek Valley fill alluvium are 84 ft/yr, 145 ft/yr, and 20 ft/yr, respectively (Rockwell International, 1987a). The average ground-water flow velocities calculated for various surficial materials assume the materials are fully saturated year round. However, as discussed above, portions of the Rocky Flats Alluvium, colluvium, and valley fill alluviums are not saturated during the entire year. Thus, dissolved constituents in the shallow flow system migrate at less than the calculated velocities for the entire year.

Bedrock Ground Water

The majority of ground-water flow in the Arapahoe Formation occurs in the lenticular sandstones contained within the claystones. Ground-water recharge to sandstones occurs as infiltration from alluvial ground water where sandstones subcrop beneath the alluvium and by leakage from claystones overlying the sandstones. Usable ground water occurs in the Arapahoe Aquifer. Water in sandstones of the Arapahoe Aquifer are used for irrigation, livestock watering, and domestic purposes east of RFP.

There is a strong downward gradient between ground water in surficial materials and bedrock. Vertical gradients range from 0.31 ft/ft between wells 35-86 and 34-86 to 1.05 ft/ft between wells 41-86 and 40-86. These gradients imply a relatively high hydraulic conductivity contrast between the sandstones and claystones, which is supported by hydraulic conductivity test results.

Flow within sandstones is regionally west to east. The geometry of the ground-water flow path in the bedrock is not fully understood at this time because it depends upon the continuity of the sandstones and their interconnection. Evaluation of the lateral extent and degree of interconnection of the sandstone units is a primary goal of the Phase II and Phase III Remedial Investigations for Operable Unit 2.

Hydraulic conductivity values for Arapahoe sandstones were estimated from drawdown-recovery tests performed in 1986, slug tests performed in 1987, and packer tests performed in 1986 and 1987. The maximum horizontal ground-water flow velocity in sandstone is 75 ft/yr using a hydraulic conductivity of 83 ft/yr, an average horizontal gradient of 0.09 ft/ft, and an assumed effective porosity of 0.1.

2.2.4 Ecology

Within the plant boundaries a variety of vegetation thrives. Included are species of flora representative of tall grass prairie, short grass plains, lower montane, and foothill ravine regions, with none being on the endangered species list. It is evident that the vegetative cover along the Front Range of the Rocky Mountains has been radically altered by human activities such as burning, timber cutting, road building, and overgrazing for many years. Since the acquisition of the Rocky Flats Plant property, vegetative recovery has occurred as evidenced by the presence of grasses like big bluestem and sideoats grama (two disturbance sensitive species). No vegetative stresses attributable to hazardous waste contamination have been identified (DOE, 1980).

The animal life inhabiting the Rocky Flats Plant and its buffer zone consists of species associated with western prairie regions. The most common large mammal is the mule deer, with an estimated 100-125 permanent residents. There are a number of small carnivores, such as the coyote, red fox, striped skunk, and long-tailed weasel. A profusion of small herbivore species can be found throughout the plant and buffer zone consisting of species such as the pocket gopher, white-tailed jackrabbit, and the meadow vole (DOE, 1980).

Commonly observed birds include western meadowlarks, horned larks, mourning doves, and vesper sparrow. A variety of ducks, killdeer, and red-winged black birds are seen in areas adjacent to ponds. Mallards and other ducks frequently nest and rear young on several of the ponds. Common birds of prey in the area include marsh hawks, red-tailed hawks, ferruginous hawks, rough-legged hawks, and great horned owls (DOE, 1980).

Bull snakes and rattlesnakes are the most frequently observed reptiles. Eastern yellow-bellied racers have also been seen. The eastern short-horned lizard has been reported on the site, but these and other lizards are not commonly observed. The western painted turtle and the western plains garter snake are found in and around many of the ponds (DOE, 1980).

2.2.5 Sensitive Environments and Endangered Species

The Endangered Species Act of 1973 (Public Law 93-0205), as amended, provides that all federal agencies implement programs for the conservation of listed endangered and threatened species. Federal agencies must ensure that actions authorized, funded, or carried out by them will not jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of historical/archaeological features or critical habitats.

The U. S. Fish and Wildlife Service (USFWS) has indicated that the two endangered species of interest in the RFP area are the bald eagle and the black-footed ferret (Rockwell International, 1988d). Prairie dog towns provide the food source and habitat for ferrets. Since there are no prairie dog towns in or near the 881 Hillside Area which is near the 903 Pad, Mound and East Trenches, the USFWS has determined that ferrets probably do not exist in the investigation area. Bald eagles are occasional visitors to the area, primarily during migration times. Sightings are rare and little suitable habitat occurs on plant site other than some perching locations. No nests occur on plant site. The proposed action will not adversely affect the bald eagle. The USFWS has concurred with these findings subsequent to a field visit on 6/15/88.

Other animal species of interest that exist in the RFP area include burrowing owls and Swainson's hawks. Cottonwood trees within approximately 1/4 mile of the 903 Pad, Mound, and East Trenches Areas were investigated to determine if any raptor nests existed and none were found. The trees will be reinspected in the spring to ensure that activities do not disturb nesting or raising of young. The nearest population of burrowing owls is approximately two miles to the east.

The 903 Pad, Mound, and East Trenches Areas are not used, nor intended for use, as a public or recreational area, nor for the development of any unique natural resource. No unique ecosystems were found at RFP during extensive biological studies (DOE, 1980).

2.2.6 Wetlands

Consultation with the United States Fish and Wildlife Service (USFWS) and the U. S. Army Corps of Engineers was conducted in the spring of 1988. Wetlands at the plant site were delineated. The proposed action is not located in the delineated wetlands. Aerial photography imagery for the 903 Pad, Mound, and East Trenches Areas was examined for wetlands identification on September 13, 1989, followed by limited site inspection. Two isolated stands of wetlands vegetation containing common cat-tail (Typha latifolia) were located primarily within SWMU #140, where groundwater flowing towards the terrace edges emerges as seeps or springs at the contact between the alluvium and bedrock. The two areas are less than 20 square feet in size.

Wetlands areas have been identified along both the Woman Creek and South Interceptor Ditch drainage areas. Evenly-spaced drop structures along the South Interceptor Ditch have lowered flow velocities, increased sediment accumulation, and created fairly dense linear stands of wetlands. From a point due south of the 881 Building and extending to the C-2 Pond, approximately 0.15 acres of wetland are contained within this portion of the South Interceptor Ditch. The species are observed to be primarily cat-tails (greater than 95% predominance), spike rush (Eleocharis macrostachya) and bull rush (Scirpus americanus). The wetlands function primarily as flow attenuation with additional minor contribution in wildlife habitat and water quality enhancement.

2.2.7 Historic Sites

The 903 Pad, Mound and East Trenches Areas have been highly disturbed over a number of years. Due to this disturbance and the topographic position of the program area, the State Office of Archeology and Historic Preservation has determined that this action will not impact cultural resources (Burney, 1989).

An archaeological and historical survey of the RFP was conducted between July 18 and August 22, 1988 which determined two sites have potential eligibility to the National Register of Historic Places. However, insufficient information currently exists to make this determination. These two sites are located northwest and southwest of the investigation area, and will not be disturbed by the proposed action (Burney, 1989).

2.3 CONTAMINANTS – DESCRIPTION AND SOURCES

2.3.1 Background Characterization

In order to facilitate the interpretation of chemical results in non-background areas, a background characterization program has been implemented to define the spatial and temporal variability of naturally occurring constituents. Field work was conducted in 1989 and a draft Background Geochemical Characterization Report was prepared and submitted to the regulatory agencies December 15, 1989 (Rockwell International, 1989b). The document summarizes the background data for ground water, surface water, sediments, and geologic materials, and identifies preliminary statistical boundaries of background variability. Spatial variations in the chemistry of geologic materials and water were addressed by placing sample locations throughout background areas at the Plant. The goal of evaluating temporal variations in water chemistry has not yet been achieved because at least two years of quarterly data are needed. The draft report will be updated in 1990 by incorporation of analytical data that were unavailable in December 1989, including a second round of ground-water samples for which laboratory analyses were not available. The information in the draft background geochemical report has been used to preliminarily characterize inorganic contamination at the 903 Pad, Mound, and East Trenches Areas.

2.3.2 Ground Water Contamination

The following discussion of volatile organics, metals and inorganics focuses on ground water sampling results for the second quarter of 1989. These are the most recent data pertaining to the same season for which the background levels were determined. However, the discussion of 1989 radionuclide data relies on first quarter results because complete second quarter data are unavailable.

2.3.2.1 Volatile Organic Contamination

CCl₄, PCE, and TCE are the primary volatile organic contaminants in the unconfined ground-water flow system. Figures 2-6 through 2-8 show isopleths for these compounds in the second quarter of 1989 for both unconfined alluvial and bedrock wells. Table 2-1 presents all volatile organics above detection limits in the unconfined ground-water system.

Carbon Tetrachloride

Carbon tetrachloride occurs in ground water east, southeast and northeast of the 903 Pad Area (Figure 2-6). Of the downgradient wells in this area, 1-71 and 15-87 show the highest levels of CCl₄ [690J and 1100J micrograms per liter (ug/l)]. (These relatively high concentrations of CCl₄ are flagged "J" because the measurement of the undiluted samples exceeded the range of the standard curve, and the laboratory diluted samples were less than the range of the standard curve. Although this compromises the precision of the data, these results indicate that significant CCl₄ contamination exists). The northern East Trenches may be a second source of CCl₄, for the downgradient concentrations (in wells 36-87 and 42-86) are greater than the upgradient concentrations (in wells 17-87 and 25-87).

Tetrachloroethene

The Mound Area appears to be the primary source of PCE within the study area (Figure 2-7); as well 1-74 contained 45000 µg/l. A plume of PCE with concentrations greater than 100 µg/l extends east and

**VOLATILE ORGANIC COMPOUNDS DETECTED IN
UNCONFINED GROUND WATER
SECOND QUARTER 1989**

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TABLE 2-1 (cont.)

VOLATILE ORGANIC COMPOUNDS DETECTED IN
UNCONFINED GROUND WATER
SECOND QUARTER 1989

| Matrix | Well | Date Sampled | Carbon Tetra- chloride (ug/L) | Tetra- chloro- ethene (ug/L) | Trichloro- ethene (ug/L) | Chloro- form (ug/L) | Methylene Chloride (ug/L) | 1,1-Di- chloro- ethane (ug/L) | 1,1-Di- chloro- ethene (ug/L) | Vinyl Chloride (ug/L) | Acetone (ug/L) | Carbon Disulfide (ug/L) | Total-1,2- Dichloro- ethene (ug/L) | Toluene (ug/L) |
|------------------------|-------|--------------|--|---------------------------------------|--------------------------------|---------------------------|---------------------------------|--|--|-----------------------------|-------------------|-------------------------------|---|-------------------|
| Weathered Claystone | 1-71 | 5/01/89 | 690J | 69 | 230 | 200 | | | | | | | | |
| | 2-71 | 5/01/89 | | 8 | 440 | 7 | | | | | | | | |
| | 1-74 | 5/03/89 | | 45,000 | 1,800 | | | | | | | | | |
| | 3-74 | 5/08/89 | 1,100 | 50 | 25 | 11J | | | | | | | | |
| Weathered Sandstone | 62-86 | 4/17/89 | | | | | | | | | | | | |
| | 9-87 | 5/01/89 | | | | | | | | | | | | |
| | 11-87 | 5/02/89 | Dry | | | | | | | | | | | |
| | 12-87 | 5/02/89 | Dry | | | | | | | | | | | |
| | 14-87 | 4/24/89 | 160J | | | | | | | | | | | |
| | 23-87 | 5/03/89 | | 4J | 68 | 16 | | | | | | | | |
| | 25-87 | 5/08/89 | 290 | 74R | 120 | 5J | | | | | | | | |
| | 36-87 | 5/08/89 | 610 | 840 | 12,000 | 290E | | | | | | | | |
| | | | | 350E | | | | | | | | | | |

2JB

2J

J - Value estimated below detection limit
 E - Value estimated
 R - Value rejected by data validation
 B - Compound also detected in associated blank.

southeast (downgradient) from the Mound Area to at least well 36-87. The extent of this plume is not well defined. PCE was also detected in wells southeast (downgradient) of the 903 Pad and Trench T-2 (2-71, 15-87, and 1-71), although the concentrations were lower than in the Mound Area wells. An estimated concentration of 8J $\mu\text{g/l}$ at well 64-86 is the only PCE occurrence outside the limits defined by the wells listed above. This low and isolated result does not provide adequate evidence of PCE contamination at well 64-86.

Trichloroethene

The distribution of TCE (Figure 2-8) indicates that all three RI areas are sources of this volatile organic. TCE in wells 1-71, 2-71, 14-87, and 15-87 suggests the upgradient 903 Drum Storage Site and possibly Trench T-2 and the Reactive Metal Destruction Site as potential sources. Similarly, TCE in wells 1-74, 17-87, and 35-86 suggests the Mound Area as a TCE source. TCE contamination downgradient of Trenches T-3 and T-4 indicates the East Trenches as potential sources. Well 36-87 within this area exhibited the highest concentration, 12000 $\mu\text{g/l}$.

Other Volatile Organic Compounds

Second quarter 1989 data indicate contamination in ground water by volatile organic compounds other than CCl_4 , PCE and TCE, but to a much lesser extent. Ground water from well 36-87 indicates levels of 1,1-DCA, 1,1-DCE and vinyl chloride to be 59 $\mu\text{g/l}$, 13 $\mu\text{g/l}$ and 470 $\mu\text{g/l}$, respectively. This suggests the Mound Area as a source of these contaminants. Chloroform was detected at 200 $\mu\text{g/l}$ southeast of the 903 Pad in well 1-71. Chloroform was also estimated at 290E $\mu\text{g/l}$ in well 36-87 suggesting the East Trenches Area to be a potential source of this contaminant. Methylene chloride, acetone, carbon disulfide and 1,2-DCE (total) were all estimated at values below detection limit.

2.3.2.2 Inorganic Contamination

Major Ions

Major ions and total dissolved solids (TDS) are somewhat elevated above background throughout and downgradient of the 903 Pad, Mound and East Trenches Areas. Total dissolved solids typically ranged between 400 and 1000 milligrams per liter (mg/l); chloride was generally 38-100 mg/l, nitrate was 2-10 mg/l, and most sulfate concentrations were between 10 and 100 mg/l in the second quarter of 1989. In general, major cations were accordingly elevated. The highest concentrations of major ions are in well 29-87 southeast of the 903 Pad as discussed below, although the northernmost wells (34-87 and 35-87) were quite high also (< 1000 TDS).

Metals

In the second quarter 1989 data for all the wells at the 903 Pad, Mound and East Trenches Areas, all of the dissolved metals except beryllium, cadmium, cobalt, cesium, and thallium exceeded background, and all the wells had some subset of these metals occurring above background concentrations. When multiple samplings are accounted for, it becomes more apparent that only a subset of the analytes repeatedly exceed background and/or exceed background by a wide margin. For example, barium and strontium exceeded background more consistently than all of the other trace metals, with maximum concentrations of 0.93 mg/l and 7.7 mg/l, respectively (both in well 14-87).

Radionuclides

All three uranium isotopes (U-234, U-235, and U-238) were above background at the 903 Pad, Mound and East Trenches Areas, in the first quarter of 1989. For example, several wells within or downgradient of the 903 Pad Area exhibit uranium 238 in excess of background, with a maximum of 28 ± 2 pCi/l at well 12-87 (in weathered sandstone). Mound Area wells 23-87 (in weathered sandstone) and 17-87 (in Rocky Flats Alluvium) both contained uranium above background, whereas wells 1-74 (in weathered claystone) and 35-86 (in valley fill alluvium) did not contain above background uranium. The only well that did not have above background

concentrations of uranium in the vicinity of the East Trenches Areas was 3-74 (in weathered claystone). The areal distribution of uranium in this area is not well known. In general, other radionuclides were not present above background in the first quarter of 1989, but there were earlier samples that contained plutonium and/or americium above background. Results at wells 15-87 and 11-87 were the most elevated (plutonium - $0.522 \pm .117$ pCi/l and 0.199 ± 0.07 pCi/l; americium - 0.831 ± 0.148 pCi/l and $0.06 \pm .05$ pCi/l).

2.3.3 Soil Contamination

The extent of soil contamination at the 903 Pad, Mound, and East Trenches Areas was determined from soil samples collected during the Phase I RI. Soil samples were taken from boreholes drilled into and adjacent to known SWMU locations. Boreholes were drilled into SWMUs to the extent practical; however, boreholes were not drilled into sites still containing wastes (the trenches and 903 Pad) due to potential health hazards to field workers and potential for release of waste constituents to the environment. The following discussion is considered a preliminary assessment because wastes were not sampled and data is still being validated.

Plutonium and americium are the principle radionuclide contaminants exhibiting elevated concentrations in surface soils. Because many of the surface soil samples were mixed into large composites, the Phase I RI data do not rule out the presence of radionuclides other than plutonium and americium. Cesium-137, tritium, and uranium were detected, albeit at near-background concentrations and in fewer than ten samples. The Phase I RI results are consistent with a recent aerial radiological survey (EG&G, 1989). The radioactivity detected in that survey was associated with known radioactive material storage and handling areas, and was attributed to plutonium, americium, and a uranium decay product. The survey indicated elevated americium in soils at the 903 Pad Lip Site. The cesium-137 activity was at a level consistent with global fallout and not enriched in the Plant area.

2.3.3.1 903 Pad Area

903 Pad Drum Storage and 903 Pad Lip Site (SWMU 112 and 155)

Based on results of the soil boring program, it appears that soils surrounding the 903 Drum Storage and 903 Pad Lip Sites are contaminated with plutonium, americium, and phthalates (Rockwell International, 1987b). Radionuclide contaminants were found only in the uppermost samples; Hazardous Substances List (HSL) volatile organics were below detection limits in boreholes surrounding the 903 Pad with the exception of bis (2-ethylhexyl) phthalate. Acetone and methylene chloride were reported but are suspected laboratory artifacts as indicated by contaminated laboratory blanks. However, volatile organics are present in ground water at the site and are expected to be present in soils directly beneath the 903 Pad. Based on soil boring results, the extent of volatile organic soil contamination at the 903 Drum Storage Site appears to be confined to the area immediately beneath and adjacent to the pad.

Soils near the 903 Pad and Lip Sites contain aluminum, arsenic, barium, cadmium, calcium, iron, mercury, manganese, lead, antimony, vanadium, and zinc above background. Of those elements, only manganese was reported above background in more than two samples and by more than a factor of two above the tolerance limit.

The Phase I RI results provide evidence of plutonium and americium contamination of surface soils. For example, plutonium and americium were significantly elevated in a 0-9 foot composite sample [plutonium - 180 picoCuries per kilogram (pCi/kg); americium - 22 pCi/kg].

Based on results of a soil boring program (Rockwell International, 1987a), it appears that soil within the 903 Pad Lip Site is contaminated with plutonium, americium, and phthalates. Radionuclide contamination (plutonium and americium) appears to be limited to surficial soils.

Trench T-2 Site and Reactive Metal Destruction Site (SWMU Ref. Nos. 109 and 110)

Volatile and semi-volatile organics were detected just south of Trench T-2; maximum concentrations of detected compounds were 17,000 micrograms per kilogram ($\mu\text{g/kg}$) of trichloroethene (TCE), 10,000 $\mu\text{g/kg}$ of PCE, 250 $\mu\text{g/kg}$ of 1,1,1-trichloroethane (1,1,1-TCA), 1900 $\mu\text{g/kg}$ bis(2-ethylhexyl) phthalate, 780 $\mu\text{g/kg}$ of ethylbenzene, 3300 $\mu\text{g/kg}$ of total xylenes, and 1,100 $\mu\text{g/kg}$ of acetone (also detected in the blank). Solvent contamination was also found at the eastern corner of Reactive Metal Destruction Site. PCE at 210 $\mu\text{g/kg}$, carbon tetrachloride (CCl_4) at 100 $\mu\text{g/kg}$, bis(2-ethylhexyl) phthalate (3400 $\mu\text{g/kg}$), and carbon disulfide at 58 $\mu\text{g/kg}$ were detected below the water table in one borehole.

Numerous samples contained arsenic and cadmium above background in the vicinity of Trench T-2 and the Reactive Metal Destruction Site. Boreholes near T-2 contained above background arsenic and cadmium in both colluvium and claystone, reaching a maximum of 20 mg/kg arsenic in claystone and 5.4 mg/kg cadmium in colluvium. Only one sample showed above background barium, but the margin above background was very large (1899 mg/kg).

Plutonium and americium were elevated above background in a composite sample (0-9 feet) near Trench T-2, and in surface and nine-foot bedrock samples near the Reactive Metal Destruction site.

2.3.3.2 Mound Area

Mound, Oil Burn Pit, and Trench T-1 Sites (SWMU Ref. Nos. 113, 158 and 108)

No volatile organic contamination was found at the Mound Site, but HSL organics were present closer to Trench T-1 and the Oil Burn Pit [acetone, methylene chloride, 1,2-dichloroethane (1,2-DCA), N-nitrosodiphenylamine, di-n-butyl phthalate, and bis(2-ethylhexyl) phthalate]. The detected volatiles were all estimated at concentrations below the detection limit or were present in the associated laboratory blanks at concentrations within a factor of two of the concentration in the sample (not reportable following CLP protocol). Of the semi-volatiles listed above, only bis(2-ethylhexyl)phthalate was found at non-estimated concentrations,

and it was only slightly above the detection limits. There is inadequate evidence to demonstrate significant organic contamination of soils in the vicinity of SWMUs 108 and 158.

Major soil cations, calcium, magnesium, sodium, aluminum, and iron all occurred well above background in soils of the Mound Area. Calcium was enriched by more than a factor of ten. Copper, vanadium, arsenic, cadmium, barium and lead all occurred above background in some samples from these soils.

Plutonium and americium were elevated in composited surface soil samples adjacent to Trench T-1. Plutonium was detected at 1.5 ± 0.2 pCi/g, and americium was detected at 0.30 ± 0.13 pCi/g in a 0 to 12 foot composite sample. Plutonium was also detected at 0.53 ± 0.16 pCi/g in zero to five foot composite sample. Since radionuclide contamination is limited to soil samples which include the ground surface, wind dispersal of plutonium and americium from the 903 Drum Storage Site is the likely source of these contaminants.

Pallet Burn Site (SWMU Ref. No. 154)

Soil organic contamination is apparent at SWMU 154. Maximum organic compound levels in soil samples were 580 $\mu\text{g/kg}$ of bis(2-ethylhexyl) phthalate, 32 $\mu\text{g/kg}$ of 1,2-DCA, 170 $\mu\text{g/kg}$ of acetone, and 20 $\mu\text{g/kg}$ of PCE. No other organic contaminants were detected, and no metals were reported above background.

2.3.3.3 East Trenches Area

Trenches T-3, T-4, T-10, and T-11 (SWMU Ref. Nos. 110, 111.1, 111.7, and 111.8)

Soils near Trenches T-3, T-4, T-10 and T-11 exhibited volatile organics above detection limits. Maximum concentrations of 1,1,1-TCA were 130 $\mu\text{g/kg}$, 180 $\mu\text{g/kg}$, and 190 $\mu\text{g/kg}$. Numerous occurrences of acetone and methylene chloride ranged up to several hundred $\mu\text{g/kg}$. In some soil samples, the acetone results did not have associated laboratory blank contamination and therefore may reflect actual contamination. N-nitrosodiphenylamine was present at estimated concentrations below 100 $\mu\text{g/kg}$.

Calcium was the only major ion in alluvium that was present above background. Its concentration ranged between 50,000 and 120,000 mg/kg, well above the tolerance limit of 43,079 mg/kg. Some of the soil samples contained arsenic, cadmium, manganese, zinc, vanadium, and chromium above background.

Plutonium was elevated in one surface sample (0.82 ± 0.12 pCi/g).

Trenches T-5 through T-9 (SWMU Ref. Nos. 111.2 through 111.6)

Volatile organic contaminants bis(2-ethylhexyl) phthalate, N-nitrosodiphenylamine, acetone, and methylene chloride are present in alluvium and claystone in the vicinity of the southern trenches. Most of these occurrences are associated with contaminated laboratory blanks, but occasionally substantial concentrations were reported without a corresponding occurrence in the blanks. Soils were found to contain 1,2-DCA (maximum 110 μ g/kg), TCE (maximum 150 μ g/kg), and PCE (maximum 62 μ g/kg).

Major ions, calcium, magnesium, iron and potassium were present above background in alluvium near Trenches T-5 through T-9. Arsenic, cadmium and lead were above background in a total of eight samples.

Plutonium was detected in the majority of the uppermost soil samples (maximum was 6.0 ± 0.2 pCi/g in), and in only two subsurface samples (0.98 ± 0.24 pCi/g and 0.14 ± 0.12 pCi/g.). Americium was detected in two surface composites (0.14 ± 0.10 pCi/g and 0.53 ± 0.20 pCi/g).

Volatile organic contamination is highest south of the trench. Plutonium was detected in the zero to nine foot composite sample at 3.2 picocuries per gram (pCi/g) with a counting error of 0.4 pCi/g, and americium was detected at 0.22 with a counting error of 0.18 pCi/g. The maximum concentrations of volatile organics detected were 16,000 micrograms per kilogram (μ g/kg) of TCE, 10,000 μ g/kg of PCE, 250 μ g/kg of 1,1,1-TCA, and 1,100 μ g/kg of acetone (also detected in the blank). It is postulated that radionuclide contamination originated from the 903 Drum Storage Site via wind dispersal, and the solvent contamination is due to a release from Trench T-2.

2.3.4 Sediment Contamination

Sediment stations have been established along the Woman Creek and the South Walnut Creek drainages. As shown on Figure 2-9, stations SED-28, SED-29, and SED-25 are located within the South Interceptor Ditch in the Woman Creek drainage. SED-30 and SED-31 are seeps on the South Interceptor Ditch berm near station SED-29. SED-27 and SED-26 are along Woman Creek just upstream of Pond C-2. Stations SED-11, SED-12, and SED-13 are located along South Walnut Creek. SED-11 is the most upgradient station, SED-12 is just upstream of Pond B-1, and SED-13 is just downstream of Pond B-5.

2.3.4.1 Woman Creek

Plutonium concentrations in the sediments at sampling locations SED-1 and SED-2 on Woman Creek and its tributary were 0.06 (error of 0.02) and 0.80 (error of 0.09) pCi/g. SED-2 is located on an ephemeral stream north of Woman Creek, which drains the East Trenches Areas. The concentrations at SED-1 and SED-2 are similar to those reported for soils in this vicinity, implying that plutonium concentrations are due to resuspension and settling of contaminated dust from the 903 Pad Area (Rockwell International, 1987a). Surface water stations at SED-1 (SW-1) and SED-2 (SW-2) were both dry at the time sediment samples were collected.

2.3.4.2 Woman Creek Drainage

Chloromethane was present in SED-29 (60 $\mu\text{g/kg}$), and chloroform and trichloroethene were reported in SED-31 (18 $\mu\text{g/kg}$ and 8 $\mu\text{g/kg}$, respectively). Several sediment samples contained methylene chloride and acetone at very low concentrations. These compounds were frequently found in associated blanks. SED-30 contained 220 $\mu\text{g/kg}$ acetone at one sampling, but acetone was also present in the blank for this sample and was undetected in two other sampling events for this station in 1989. Laboratory artifact is suspected for acetone and methylene chloride results in this area. The only other volatile organic compounds detected in the Woman Creek drainage sediment samples were TCE (8 $\mu\text{g/kg}$) at SED-31 (estimated below detection limits elsewhere), and toluene estimated below detection limit at SED-29 and SED-30.

Of the metals, beryllium, lithium, silver, and tin were notably elevated above background in the sediment of the South Interceptor Ditch and Woman Creek. Concentrations of silver are greater than five times the upper limit of the background range (as high as 49.1 mg/kg) at stations SED-29, SED-30, and SED-25. Beryllium was not detected in the background samples (<1.1 mg/kg) but occurs at concentrations ranging from 3.8 to 15.0 mg/kg in all the sediment samples collected from the South Interceptor Ditch and Woman Creek. Although tin was not above background (<22.8 mg/kg) at SED-27, SED-28, and SED-31, it occurred in a range from 364 to 1080 mg/kg in stations SED-25, SED-26, SED-29, and SED-30.

Plutonium was above background at stations SED-25, SED-26, SED-29, and SED-30, ranging in concentration from 0.3 to 3.3 pCi/g. Contaminated surface soil from the 903 Pad Area, transported by wind, may be the source of this plutonium.

2.3.4.3 South Walnut Creek Drainage

Limited 1989 data exist for the three sediment stations on South Walnut Creek. There are no data for SED-12 and SED-13, and only volatiles, metals, and other inorganics data exist for SED-11.

At SED-11, CHCl_3 , CCl_4 , TCE, PCE, and acetone were present at 10, 52, 17, 39, and 167 $\mu\text{g/kg}$, respectively. This is consistent with the data for surface water station SW-61 that indicates these are surface water contaminants at this location.

As in the Woman Creek drainage, beryllium, lithium, silver, and tin are elevated in the sediments at SED-11. They occurred at concentrations of 2.5, 7.2, 15.0, and 404 mg/kg, respectively. Zinc, which is a known contaminant of ground water and surface water in this vicinity, was also notably elevated occurring at a concentration of 735 mg/kg (the upper limit of the background tolerance interval is 93 mg/kg).

2.3.5 Surface Water Contamination

Twenty-six surface water and surface seep samples in the vicinity of the 903 Pad, Mound, and East Trenches Areas were collected during field activities. The following discussion is based on all available data

because many seeps or stream stations are dry during some samplings. Appendix A contains all available data from 1986 through 1990. These data have been summarized (Appendix B) and compared to Applicable or Relevant and Appropriate Requirements (ARARs) (see Section 3.0 for ARAR identification). The following discussion is in reference to the Appendix B tables. Total radiochemical and metals data, although presented in the Appendix, are not discussed because an assessment methodology that accounts for varying concentrations of suspended solids is still being developed.

A discussion of surface water chemistry for the 903 Pad, Mound, and East Trenches Areas is also one of ground-water chemistry as most of the surface water samples collected for this investigation are from seeps that represent the surfacing of ground water. In addition there is frequent interaction of surface water and ground water in the drainages. The seeps are ponded water located downslope and southeast of the 903 Pad Area or located downslope and north of the Mound Area and East Trenches Area. Surface water flowing in drainages was sampled at stations on the South Interceptor Ditch and Woman Creek just upstream of Pond C-2 and at stations upstream of the B-series ponds on South Walnut Creek. The B-series ponds were not sampled for this investigation, as they will be subsequently investigated as part of another operable unit. Surface water monitoring locations are shown on Figure 2-9.

2.3.5.1 Surface Water Stations Southeast of 903 Pad Area

There are several seeps downslope to the southeast of the 903 Pad. Surface water stations established at these seeps in the 903 Pad Lip Area are designated SW-50, SW-51, SW-52, SW-55, SW-57, SW-58, and SW-77. Station SW-50 is closest to the 903 Pad, and SW-57 and SW-52 are south of SW-50. SW-51 and SW-58 are located in a ditch along the road east of SW-50; however only overland flow of seepage from SW-50, SW-52, and SW-57 will also enter the ditch. Water in the ditch passes under the road south of these locations through a culvert. The discharge of the culvert is SW-55. SW-77 another seep located on the east side of the road, just north of SW-55. It is noted therefore, that SW-51, SW-58, and SW-55 are physically connected and likely receive flow from SW-50, SW-52, and SW-57. Farther downgradient stations include seeps at SW-53, SW-62, SW-63, and SW-64; SW-27, SW-30, SW-54, and SW-70 on the South Interceptor Ditch; and SW-26, SW-28, and SW-29 on Woman Creek.

Data for seeps in the vicinity of the 903 Pad Lip Site and farther downgradient at SW-53, SW-63, and SW-64 indicate organic contamination. Contaminants in seeps in the vicinity of the 903 Lip Site include 1,1-DCE, 1,2-dichloroethene (1,2-DCE), CCl_4 , TCE, and PCE with concentrations of CCl_4 and TCE exceeding 1000 $\mu\text{g/l}$. 1,2 DCE and TCE are occasionally present at SW-53, low concentrations of CCl_4 and TCE ($<20 \mu\text{g/l}$) occur at SW-63, and low concentrations of TCE occur at SW-64. Methylene chloride also occasionally occurs in these seeps but at concentrations near the detection limit and frequently also occurs in the laboratory blanks. Low and very infrequent concentrations of these and other volatiles occur at seep SW-62 as well as stations along the South Interceptor Ditch and Woman Creek are free of organic contamination. The data do not provide convincing evidence of impacts at these stations; however, the volatile organic concentrations in the upgradient seeps suggest that a solvent plume within alluvial ground water is migrating to the southeast, which is consistent with the alluvial ground-water flow direction. It is inferred that organic contaminated alluvial ground water approaches the South Interceptor Ditch and Woman Creek.

With respect to inorganic and dissolved radionuclide contamination, there are somewhat elevated concentrations of TDS, major ions, strontium, zinc, and uranium at most of these stations. Unlike the absence of volatiles in surface water at stations along the South Interceptor Ditch (SW-70, SW-30, SW-54, and SW-27), all have somewhat elevated uranium concentrations (generally less than 10 pCi/l of total uranium). These concentrations are usually above ARAR (5 pCi/l). Although the 903 Pad Area cannot be ruled out as the source of the uranium, the occurrence of elevated uranium as far upgradient as SW-70 suggests the 881 Hillside Area as a potential source. Alluvial ground water at the 881 Hillside contains above background levels of uranium.

Seeps in the vicinity of the 903 Pad Lip Site (SW-50, SW-53, and SW-54), had detectable plutonium and/or americium during one event in 1989 (two events for SW-53). The samples contained substantial suspended solids and were not filtered at the time of collection, and surface soils in the vicinity of the seeps are contaminated with radionuclides. Furthermore, total radiochemistry data do indicate notably higher plutonium and americium concentrations than in filtered samples, demonstrating that most of the radionuclides are in a particulate form. Therefore, the local soils represent the most direct potential source for seep contamination. However, there were traces of plutonium and americium in a few ground-water samples

(highest concentrations at wells 15-87 - 0.522 ± 0.117 pCi/l and 0.031 ± 0.148 pCi/l, respectively) so ground water is also a potential source of radionuclides in seeps, albeit a less significant one. It is noted that plutonium and americium are essentially insoluble but can migrate in colloidal form, and colloidal-size particles can pass through 0.45 um filters such as those used in the Phase I RI (Puls and Barcelona, 1989).

Regardless of the transport mode, total plutonium concentrations occur above background at station SW-29 on Woman Creek (range: $< \text{MDA} - .315 \pm .115$ pCi/l), and dissolved plutonium was just detectable during one sampling event ($.159 \pm .142$ pCi/l). Dissolved plutonium was also just detectable at station SW-70 on the SID ($.11 \pm .09$ pCi/l); however, the total plutonium concentration was $0.011 \pm .057$ pCi/l during this sampling event rendering this data questionable. The one datum that exists in the remedial investigation data base indicates total plutonium is not above background in Pond C-2 (dissolved radionuclide data are unavailable).

Surface water (and ground-water) sampling at these stations will continue for the Phase II RI to better define surface water/ground-water interaction and the extent of contamination. Samples will be analyzed for both total and dissolved radionuclides and metals.

2.3.5.2 Upper South Walnut Creek

At the Mound Area, station SW-60 is a corrugated metal pipe discharging South Walnut Creek flow which originates to the west of SW-56 (not sampled in 1989). Station SW-56 and SW-101 are on a ditch that appears to be seepage from the base of the hill to the south. The ditch is not part of the main flow of South Walnut Creek, as the creek is routed beneath this area by the corrugated metal pipe. Water in the ditch eventually discharges to South Walnut Creek through a concrete pipe. The flow in South Walnut Creek upstream of Pond B-4 is primarily the combined flow from the discharge of these culverts and a spring (SW-59) located at the base of the hill to the south and downstream of the culverts. This combined flow is sampled at SW-61 located at the confluence.

The upper reaches of South Walnut Creek as characterized by data for stations SW-56, SW-59, SW-60, SW-61, and SW-101 contain CCl_4 , PCE, and TCE in concentrations in excess of $200 \mu\text{g/l}$, with lesser and infrequent concentrations of 1,1-DCE, 1,1-DCA, 1,2-DCE, vinyl chloride, acetone, bromo-dichloromethane, and methylene chloride. The latter compounds may represent contaminants but not as convincingly as CCl_4 , PCE, and TCE. These stations also frequently have above ARAR levels of TDS and uranium. The TDS and uranium concentrations are typical of the alluvial ground water in the vicinity of the 903 Pad and Mound Areas. CCl_4 , PCE, TCE, and elevated zinc are also present in the alluvial ground water at the Mound Area.

Stations SW-21 and SW-23 approximately 500 feet farther downstream from the confluence of SW-59, SW-60, and SW-61 do not exhibit the upstream contamination. Although only one datum exists for each station, (August 1986 sampling), CCl_4 ($9 \mu\text{g/l}$) was the only volatile organic detected at SW-21, and volatile organics were absent at the further downstream station, SW-23. Although there are no August 1986 data for the upstream stations, the other results suggest the organics have volatilized over this reach.

Further surface water (and ground-water sampling) and analysis will be conducted to better define the extent and source of the contamination. However, potential sources outside the Mound Area will be investigated as another operable unit.

2.3.5.3 Seeps at the East Trenches Areas

Of the two seeps at the East Trenches Areas (SW-65 and SW-103), SW-65 has no apparent organic contamination, and SW-101 has the constant presence of CCl_4 at concentrations less than $10 \mu\text{g/l}$. Dissolved uranium was also above ARAR at SW-65. Like the 903 Pad and Mound Areas, the chemistry of these seeps is similar to the local ground water.

Sampling of both surface water and ground water will continue to better define the extent of surface and ground-water contamination in this area.

High plutonium and americium concentrations found in the seeps southeast of the 903 Drum Storage Site represent particulate forms of these radionuclides originating from contaminated soils at the surface. This is concluded because:

- 1) the seeps represent surfacing ground water and ground water does not appear to be contaminated with radionuclides,
- 2) the seep samples contained substantial suspended solids and were not filtered prior to analysis, and
- 3) surface soils are contaminated with plutonium in the vicinity of these seeps.

Data from stations SW-C1 (Pond C-1), SW-29, and SW-28, all located downstream of the 903 Pad on Woman Creek, do not show any indication of radionuclide concentrations elevated above background. 1986 data from station SW-25 on South Walnut Creek downstream of its southern tributary (Central Avenue Ditch), do not indicate radionuclide concentrations elevated above estimated background.

2.3.6 Air Contamination

The 903 Pad Area is recognized as the principal source of airborne plutonium contamination at the Rocky Flats Plant. An extensive air monitoring network known as the Radioactive Ambient Air Monitoring Program (RAAMP) is maintained at the Plant in order to monitor particulate emissions from the 903 Pad Area and other plant facilities. Historically, the particulate samplers located immediately east, southeast, and northeast of the 903 Pad, Mound, and East Trenches Areas have shown the highest plutonium concentrations. This finding is corroborated by the results of soil surveys which indicate elevated plutonium concentrations to the east, particularly southeast of the area. However, the RAAMP has found ambient air samples for plutonium to be well within the DOE guidelines of $20.0 \times 10^{-15} \mu\text{Ci}/\text{ml}$ established for the protection of human health (Rockwell International, 1987b).

2.3.7 Summary of Contamination

The Phase I RI Investigations of environmental media lead to the general conclusions that volatile organic and radionuclide contamination exists in soils, surface water and ground water around several SWMUs, and that the distribution and magnitude of the contamination can be better delineated via sampling and analysis planned for the Phase II investigation.

The report also documents the presence of several inorganic constituents above background in soils and ground water, but the data do not allow for unambiguous conclusions to be made with regard to contamination. There is considerable circumstantial evidence (listed below) that forms the basis for an alternative hypothesis: evaporative losses at ground water discharge zones may be causing accumulation of salts (in soils) and associated local changes in water quality. Many factors can cause the near-surface, fluctuating water table conditions which are a prerequisite for such evaporative concentration. Rapid slope changes can be sufficient to induce natural seepage for example, and enhanced flow along relatively impermeable rock units can form contact seeps. The presence of caliche in the vicinity of Operable Unit No. 2 indicates that long-term evaporation is a locally significant hydrogeochemical process. Also, historical changes in the local hydrological regime can cause relatively rapid salt accumulation by introducing ground water into soils which have not been previously leached. Such "saline seep" formation has been studied extensively (Miller et al, 1980). At Rocky Flats, constructed ponds and ditches may have raised the water table and caused dissolution of salts from previously unleached or less leached soils. The circumstantial evidence for a local evaporative concentrating process for ground water is as follows:

- Most of the elevated elements are not known constituents of the waste sources in Operable Unit No. 2.
- The elevated constituents do not exhibit clear gradients away from known SWMUs, or for that matter, clear horizontal or vertical gradients.
- The variability in inorganic constituent concentrations is typically very small, and almost always within an order of magnitude.
- Some of the major ions do show very pronounced elevation above background, but the highest concentrations of inorganic constituents is in a well which is one of the farthest from the SWMUs (29-87).

- Other parts of the Rocky Flats Plant show similar distributions of major and minor elements and locally very high concentrations of major ions which are not demonstrably derived from SWMUs (wells 5-86 and 6-86). The background characterization may not be adequate because the current data are based on one quarter of sampling, and the well layout was designed without the specific goal of including evaporation-prone zones.
- The wells with the high TDS and major ions commonly also have the most elevated metals and uranium. This raises the possibility that if the salinity is due to some concentrating process other than waste input, so may be some (or all) of the minor elements. This is consistent with the observation that the uranium in ground water at the 881 Hillside Area is of natural origin based on uranium 234/uranium 238 ratios. The Plant uses depleted uranium which was found to be present only in some surface soils at the 881 Hillside.

No single feature of the data listed above rules out the possibility that some or all of these inorganic constituents do represent contamination. However, when viewed in aggregate, the observations show that it is plausible, perhaps probable, that these elevated inorganic constituents do not reflect contamination. Because ground water influences the flow and quality of surface water at Operable Unit No. 2, there is also uncertainty as to whether elevated inorganic constituents in surface water represent contamination. This is further discussed in terms of treatment objectives for the interim action in Section 3.3.

The conceptual model that local concentrations are due to evaporation of shallow ground water generates several hypothesis which will be tested in part with existing data, and tested more thoroughly with data from the Operable Unit No. 2 Phase II RI activities and the on-going background characterization.

2.4 ANALYTICAL DATA

Organic, inorganic and radionuclide contaminants exist in surface water at Operable Unit 2. Volume II presents a compilation of volatile organic, inorganic and radiochemistry data for all surface water stations at Operable Unit 2 that is available at this time. These data are in the process of being validated in accordance with the ER Program Quality Assurance/Quality Control (QA/QC). At this time, only a small fraction of the data have been validated, and these data are identified in the appendices by a qualifier adjacent to each datum. The qualifier "V" means the datum is valid, "A" means the datum is acceptable with qualifications [breach of quality assurance (QA)], and "R" means the datum is rejected. Rejected data either did not conform to the significant aspects of QA/QC procedures identified in the ER Program QA/QC Plan (Rockwell International,

1989c), or there is insufficient documentation to demonstrate conformance with these procedures. These data, at best, can only be considered qualitative measures of the analyte concentrations.

2.5 SITE CONDITIONS THAT JUSTIFY AN IRA

There is no imminent threat to the public health and environment posed by contaminants in surface water at Operable Unit 2; however, localized high concentrations of VOCs and the presence of radionuclides above ARAR in seeps and the upper reach of South Walnut Creek represent sources for continuing contaminant downstream migration. Although the water is ultimately retained in downstream retention ponds, is tested, and is treated if required by the NPDES permit before release, implementation of this IM/IRA will facilitate contaminated water management and will thus be consistent with the final remedy for the site when characterization is complete. This IM/IRA will focus only on controlling the migration of hazardous substances in surface water originating from these Areas. This IM/IRA Plan does not address soil or ground water contamination at Operable Unit 2; however, a Phase II Remedial Investigation Plan has been prepared to further characterize the extent of contamination in preparation for further remedial actions at Operable Unit 2.

TABLE 3-2.3
SCREENING OF CHEMICAL SPECIFIC POTENTIAL ARARS
PERTINENT TO SURFACE WATER OPERABLE UNIT 2 IM/IRA OPTIONS

| Chemical | RCRA Subpart F Concentration Limit ^a (mg/L) | CDH Ground Water Standard Human Health/ Agriculture ^b (mg/L) | SDWA Maximum Contaminant Level (MCL) ^c (mg/L) | For Use in Special Circumstances SDWA/MCLG (mg/L) | CWA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (mg/L) | CDH Surface Water Quality Limited Standard ^d Drinking Water/ Agriculture (mg/L) | ARAR (mg/L) unless otherwise noted | Comment |
|-------------------------------------|---|---|---|---|---|--|--|--|
| <u>Conventional Pollutants</u> | | | | | | | | |
| Nitrite | - | 1.0 as N/ 10.0 as N | - | - | - | 1 ^g /10 ^h | 1.0 | CDH Surface Water Standard is applicable |
| Nitrate | - | 10.0 as N/ 100 as NO ₂ +NO ₃ -N | 10 | - | - | 10 ⁱ /100 ^h | 10.0 | CDH Ground Water Standard is |
| applicable | | | | | | | | |
| Chloride | - | 250/ | 250 | - | - | 250/ | 250 | CDH Surface Water Standard is applicable |
| Sulfate | - | 250/ | 250 ^f | - | - | 250/ | 250 | CDH Surface Water Standard is applicable |
| Bicarbonate as CaCO ₃ | - | - | - | - | - | - | NS | No Standard |

TABLE 3-2.3 (cont.)
SCREENING OF CHEMICAL SPECIFIC POTENTIAL ARARS
PERTINENT TO SURFACE WATER OPERABLE UNIT 2 IN/IRA OPTIONS

| Chemical | RCRA Subpart F Concentration Limit ^a (mg/L) | CDH Ground Water Standard Human Health/ Agriculture ^b (mg/L) | SDWA Maximum Contaminant Level (MCL) ^c (mg/L) | For Use in Special Circumstances SDWA/MCLG (mg/L) | CWA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (mg/L) | CDH Surface Water Quality Limited Standard ^d Drinking Water/ Agriculture (mg/L) | ARAR (mg/L) unless otherwise noted | -Comment |
|----------|---|---|---|---|---|--|--|----------|
|----------|---|---|---|---|---|--|--|----------|

Conventional Pollutants (cont.)

| | | | | | | | | |
|--------|---|--|------------------|---|---|---|-----|--|
| T.D.S. | - | 400 mg/L or 1.25 times background, whichever is least restrictive | 500 ^f | - | - | - | 400 | CDH Ground Water Standard is relevant and appropriate |
|--------|---|--|------------------|---|---|---|-----|--|

- (a) - 40 CFR Part 264.92 Subpart F releases from solid waste management units
(b) - 5 CCR 1002-8, Section 3.11.5, Groundwater Quality Standards
(c) - 40 CFR Part 141.11(b,c) National Primary Drinking Water Standards
(d) - 5 CCR 1002-8, Section 3.8.29, Final Rule Effective March 30, 1990.
(e) - 40 CFR Part 143.3 National Secondary Drinking Water Standards
(f) - To be applied at the point of water supply intake
(g) - In order to provide such a reasonable margin of safety to allow for
unusual situations such as extremely high water ingestion or nitrite
formation in slurries, the NO₃-N plus NO₂-N content in drinking waters
for livestock and poultry should be limited to 100 ppm or less, and the
NO₂-N content alone be limited to 10 ppm or less.
(h) - A combined total of Nitrite and Nitrate at the point of intake to the
domestic water supply shall not exceed 10 mg/L.

ARAR
CDH
CWA
MCLG
N
NS
RCRA
SDWA

Applicable or relevant and appropriate requirements
Colorado Department of Health
Clean Water Act
Maximum contaminant level goal
No standard
Resource Conservation and Recovery Act
Safe Drinking Water Act

TABLE 3-2-4
SCREENING OF CHEMICAL SPECIFIC POTENTIAL ARARS
PERTINENT TO SURFACE WATER OPERABLE UNIT 2 IM/IRA OPTIONS

| Chemical | RCRA Subpart F Concentration Limit ^a (pCi/L) | CDH Ground Water Quality Standards ^b (pCi/L) | SDWA Maximum Contaminant Level (MCL) ^c (pCi/L) | For Use In Special Circumstances SDWA/MCLG (pCi/L) | CWA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (pCi/L) | CDH Surface Water Quality Standards ^d (pCi/L) | ARAR (pCi/L) | Comment |
|---------------------------|--|--|--|--|--|---|-----------------|--|
| Radionuclides | | | | | | | | |
| Gross Alpha | - | 15 | 15 | - | - | 7 (11) | 11 | CDH Surface Water Standard is applicable |
| Gross Beta | - | 4 mrem/yr ^e | 50 | - | - | 5 (19) | 19 | CDH Surface Water Standard is applicable |
| Pu ^{238,239,240} | - | 15 | 40 ^f | - | - | .05 (.05) | .05 | CDH Surface Water Standard is applicable |
| Am ²⁴¹ | - | - | 4 ^f | - | - | .05 (.05) | .05 | CDH Surface Water Standard is applicable |
| H ³ | - | 20,000 | 20,000 | - | - | 500 (500) | 500 | CDH Surface Water Standard is applicable |
| Sr ^{89,90} | - | 8 | 8 | - | - | 5 (10) | 10 | CDH Surface Water Standard is applicable |

TABLE 3-2.4 (cont.)
SCREENING OF CHEMICAL SPECIFIC POTENTIAL ARARS
PERTINENT TO SURFACE WATER OPERABLE UNIT. 2 IM/IRA OPTIONS

| Chemical | RCRA Subpart F Concentration Limit ^a (pci/l) | CDH Ground Water Quality Standards ^b (pci/l) | SDWA Maximum Contaminant Level (MCL) ^c (pci/l) | For Use In Special Circumstances SDWA/MCL ^d (pci/l) | CWA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (pci/l) | CDH Surface Water Quality Standards ^e (pci/l) | ARAR (pci/l) | Comment |
|------------------------------|---|--|--|--|--|---|-----------------|--|
| Radionuclides (cont.) | | | | | | | | |
| Uranium ^{total} | | | | | | 40 | 40 | CDH Surface Water Standard is applicable |
| (a) - | 40 CFR Part 264.92 Subpart F releases from solid waste management units | | | | | | | |
| (b) - | 5 CCR 1002-8, Section 3.11.5(8), Basic Standards Applicable to Ground Waters of the State | | | | | | | |
| (c) - | 40 CFR Parts 141.15, 16, National Primary Drinking Water Standards | | | | | | | |
| (d) - | 5 CCR 1002-8, Section 3.8.29, Final Rule Effective March 30, 1990. Value is for Woman Creek; parentheses, Walnut Creek. | | | | | | | |
| (e) - | For beta and photon emitters, if two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 mrem per year. Except for Tritium and Strontium 90 the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents shall be calculated on the basis of a 2 liter per day drinking water intake using the 168-hour data listed in "Maximum Permissible Body Burden and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," NBS Handbook 69, as amended, August 1963, US Department of Commerce. | | | | | | | |
| (f) - | Proposed value in drinking water yielding a risk equal to that from a dose rate of 4 mrem/ year, September 30, 1986 (51 FR 34859). | | | | | | | |

ARAR - Americium
CDH - Applicable or relevant and appropriate requirements
CWA - Colorado Department of Health
H₃ - Clean Water Act
MCL - Tritium
Pu - Maximum contaminant level
RCRA - Maximum contaminant level goal
SDWA - Plutonium
Sr - Resource Conservation and Recovery Act
Safe Drinking Water Act

elements/compounds detected in surface water at Operable Unit 2 there are no ARARs for calcium, magnesium, potassium, sodium, bicarbonate, and strontium. However, the total dissolved solids ARAR establishes the acceptable aggregate concentration for the above major ions (excludes strontium). Until an acceptable risk based concentration is established for strontium, its background concentration is TBC.

3.3.1.1 Safe Drinking Water Act Maximum Contaminant Levels (MCLs) and MCL Goals

Because surface water at Operable Unit 2 is a potential source of drinking water, Maximum Contaminant Levels (MCLs) are potentially relevant and appropriate for all phases of the IM/IRA. MCLs are derived from the Safe Drinking Water Act (PL 93-523). They represent the maximum permissible level of a contaminant in water which is delivered to the free-flowing outlet of the ultimate user of a public water system [40 CFR 141.2(C)]. Maximum Contaminant Level Goals (MCLGs) have also been considered in developing clean-up standards. Section 121(d) of CERCLA, as amended by SARA, suggests that MCLGs may be appropriate under certain circumstances of the release or threatened release of hazardous substances. This is reinforced in EPA's document entitled, Draft CERCLA Compliance with Other Laws Manual, Volume II, Maximum Contaminant Level Goals, that identifies the special circumstances where MCLGs should be considered as ARAR. These circumstances generally occur when there are multiple contaminants in ground water, or where multiple pathways of exposure present extraordinary risks. According to the guidance document, the use of MCLGs should be determined on a site-specific basis in consultation with EPA headquarters.

The clean-up criteria for the surface IM/IRA at Operable Unit 2 consider MCLs and MCLGs as potential ARAR wherever such standards have been promulgated for the contaminants of concern. Proposed MCLs and MCLGs are considered TBCs in this analysis.

3.3.1.2 Ambient Water Quality Criteria

The Ambient Water Quality Criteria are non-enforceable guidance developed under the Clean Water Act. Guidance is set for surface waters for the protection of aquatic life and for the protection of human health, based on both drinking water and consuming aquatic organisms from that water. Since the IM/IRA proposed here involves the treatment and discharge of surface water, the Water Quality Criteria are considered TBC.

3.3.1.3 Colorado Surface and Ground-Water Quality Standards

The Colorado Department of Health (CDH) has adopted interim ground-water quality standards for many organic compounds. These are considered potentially relevant and appropriate for the constituents where they exist. Some of the standards are lower than the current standard detection limits for the compounds of concern. When this occurs, the detection limit will be considered as the potential ARAR.

The CDH has also promulgated ground-water quality standards for many inorganic compounds for both human health and agricultural uses. These standards are considered to be potentially relevant and appropriate since future or downgradient use of the aquifer is not restricted. Where standards exist for both human health and agricultural uses, the more stringent standard is considered to be the potential ARAR.

Permanent surface water quality standards have been adopted by CDH for Walnut Creek and Woman Creek. These include standards for many organic, inorganic and radionuclide parameters. These standards went into effect March 30, 1990 and are considered potentially applicable.

3.3.1.4 RCRA Ground-Water Protection Standards

Owners or operators of facilities that treat, store, or dispose of hazardous waste must ensure that hazardous constituents listed in 6 CCR 1007-3 and 40 CFR 264, Appendix VIII, entering the ground water from a regulated unit do not exceed concentration limits under 6 CCR 1007-3 and 40 CFR 264.94. The concentration limits include standards for 14 compounds, with background used as the standard for the other RCRA Appendix VIII constituents. These concentration limits apply to RCRA-regulated units subject to permitting (landfills, surface impoundments, waste piles, and land treatment units) that received RCRA hazardous waste after July 26, 1982. Although this area does not contain RCRA-regulated units, it does contain SWMUs. Therefore, the RCRA clean-up criteria of background concentrations for Appendix VIII constituents is potentially relevant and appropriate and are used to define ARARs in the absence of any human health-based standards. Background concentration for 40 CFR 264, Appendix IX constituents not listed in Appendix VIII are TBC.

RCRA land disposal restrictions (LDRs) for certain organic contaminants (40 CFR Part 268.40) are considered potentially relevant and appropriate for the discharge of treated ground water to either a surface or ground water body. The LDRs are technology based standards and are considered potentially relevant and appropriate in the absence of a health based standard.

3.3.1.5 Achieving Potential ARARs for the Surface Water IM/IRA

Because it has been mutually agreed among DOE and the regulatory agencies that the IM/IRA implementation be expedited (collection and treatment of surface water in 1990), it is prudent to evaluate whether it is necessary to meet all potential ARARs for the IM/IRA to be effective at reducing the potential risk to the public health and environment. It is noted that, as with removal actions, interim actions need only meet ARARs to the greatest extent practicable given the exigencies of the circumstances (40 CFR 300.65(f)). Furthermore, given that the treated effluent ultimately flows to Pond B-5 where discharge is monitored and controlled in accordance with the Plant's NPDES permit, it is not probable that surface water exceeding the CDH surface water standards for Walnut Creek will pass the property boundary.

Table 3-3 presents a summary of the constituents and their respective concentrations exceeding proposed ARARs for the seeps and other surface water stations where flow is intended for collection as part of the IM/IRA (see Section 4.0). Proposed ARARs are as defined in the final Phase II RFI/RIFS Work Plan for Operable Unit No. 2. The surface water stations include the 903 Pad Lip Site (SW-50, SW-51, SW-52, SW-55, SW-57, SW-58, and SW-77), SW-53, SW-63, SW-64, Upper South Walnut Creek (SW-56, SW-59, SW-60, SW-61, and SW-101), and SW-103. The surface water flows at the 903 Pad Lip Site will be collected at SW-55 and SW-77, and the flow in upper South Walnut Creek collected at SW-61. These particular stations receive flow from the other upstream stations within their respective groups. The data in Table 3-3 include the average and maximum concentrations at each station (or group of stations), the estimated flow at the stations (or group of stations) based on a recent flow measurement (wet season), the flow weighted average concentration for all stations, and the flow weighted maximum concentrations. Flow weighted averaging is intended to define the probable influent average and maximum concentrations for these constituents for the IM/IRA treatment system. In preparation of this information, outliers have been removed from the data set to avoid skewing the data to

SECTION 3.0

IDENTIFICATION OF INTERIM REMEDIAL ACTION OBJECTIVES

3.1 SCOPE OF INTERIM MEASURES/INTERIM REMEDIAL ACTION

The overall objective of the IM/IRA at Operable Unit 2 is the mitigation of downgradient contaminant migration within surface water and the treatment of collected surface water to achieve acceptable levels (see below). The effort is to be performed in the interest of protecting public health as well as the environment.

Specific objectives of the Operable Unit 2 IM/IRA are:

- Contain, reduce, and/or eliminate site contaminants identified as posing a threat to human health or the environment;
- Reduce or eliminate exposure to site contaminants for potential receptors by controlling potential contaminant pathways; and,
- Demonstrate technical feasibility and environmental and cost effectiveness of the interim remedial action.

3.2 INTERIM REMEDIAL ACTION SCHEDULE

| <u>Task Description</u> | <u>Start</u> | <u>Finish</u> | <u>Duration</u> |
|--------------------------------|--------------|---------------|-----------------|
| <u>IM/IRAP/EA</u> | | | |
| Internal Draft IRAP/EA | 16 Apr 90 | 25 May 90 | 6 Weeks |
| Proposed IRAP/EA to Agencies | 28 May 90 | 02 July 90 | 5 Weeks |
| DOE NEPA Review; EPA/CDH | | | |
| IRAP Review | 03 July 90 | 31 Jul 90 | 4 Weeks |
| Resolve Comments and Re-issue | 01 Aug 90 | 28 Aug 90 | 4 Weeks |
| Public Comment Period | 29 Aug 90 | 29 Oct 90 | 9 Weeks |
| Responsiveness Summary | 30 Oct 90 | 26 Nov 90 | 4 Weeks |
| DOE Completion of NEPA Process | 27 Nov 90 | 24 Dec 90 | 4 Weeks |

Bench Scale Treatability Studies and Field Treatability System

| | | | |
|--|------------|-----------|----------|
| Treatability Studies (Bench Scale) | 29 May 90 | 03 Aug 90 | 10 Weeks |
| Field Treatability System Design (Treatment System Specification and SW Collection System Design) | 03 July 90 | 03 Aug 90 | 5 Weeks |
| Procurement and System Construction | 06 Aug 90 | 21 Dec 90 | 20 Weeks |
| Field Treatability System Operation | 21 Dec 90 | | |

Additional Sources: Collection and Transport

| | | | |
|--|------------|------------|----------|
| Title 1 Design (P&ID, Site Plan, Hydraulics, Outline of Specs) | 04 June 90 | 10 Aug 90 | 10 Weeks |
| Title 2 Design (Detailed Design and Specs, O&M Manual) | 13 Aug 90 | 12 Oct 90 | 9 Weeks |
| Construction (Contractor Procurement, H&S Plan, Construction) | 15 Oct 90 | 07 May 91 | 30 Weeks |
| System Test Start-up | 08 May 91 | 20 June 91 | 6 Weeks |
| Operation of Full System | 20 June 91 | Ongoing | Open |

3.3 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR)

Response actions at Superfund sites must meet two fundamental clean-up requirements. First, they must attain a level of cleanup which, at a minimum, ensures protection of human health and the environment [CERCLA Section 121(d)(2), 42 U.S.C. Section 9621(d)(2)]. Second, it is EPA policy that CERCLA cleanups attain or exceed the requirements of all applicable or relevant and appropriate Federal and state health and environmental requirements (ARARs). This section identifies and analyzes ARARs relevant to the IM/IRA at Operable Unit 2. This remedial action is considered an on-site IM/IRA; therefore, only substantive and not administrative requirements apply.

Facilities of the U.S. Department of Energy (DOE) are required to operate under a policy of full compliance with applicable environmental regulations while conducting their missions. The DOE Rocky Flats Operations Office Environmental Restoration Program is chartered to help fulfill that commitment at the Rocky Flats Plant. The proposed actions are part of this Environmental Restoration Program.

The Environmental Restoration Program covers the major environmental regulations, such as the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Resource Conservation and Recovery Act (RCRA), National Environmental Policy Act (NEPA), Clean Air Act (CAA), Clean Water Act (CWA), Safe Drinking Water Act (SDWA), State of Colorado Ground-water Quality Standards, Toxic Substances Control Act (TSCA), and Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), with emphasis on CERCLA and RCRA.

Authority to implement the Environmental Restoration Program is primarily derived from the following DOE and AL orders:

- Comprehensive Environmental Response, Compensation, and Liability Act Program (DOE 5400.4);
- Hazardous, Toxic, and Radioactive Mixed Waste Management (DOE 5480.2 and AL 5480.2);
- Prevention, Control, and Abatement of Environmental Pollution (Ch. XII of DOE 5480.1 and AL 5480.1A);
- Environmental Protection, Safety, and Health Protection Information Reporting Requirements (DOE 5484.1 and AL 5484.1);
- Implementation of the National Environmental Policy Act (DOE 5440.1C and AL 5440.1B).

"Applicable standards" may be defined as substantive environmental protection requirements, criteria, or limitations, promulgated under Federal or state law, that specifically address a hazardous substance, pollutant, contaminant, response action, location, or other circumstances at a Superfund site. "Relevant and appropriate requirements" are those substantive environmental protection requirements, promulgated under federal or state law, that, while not jurisdictionally applicable to circumstances at the site, address problems sufficiently similar to those encountered at the site that their use is well suited to the particular site. ARARs must be identified on a site-specific, case-by-case basis.

In general, there are three categories of potential ARARs at any Superfund site. These categories are:

- Ambient or chemical-specific requirements.
 - Locational requirements.
 - Performance, design, or other action-specific requirements.
- Each category is discussed in more detail below.

3.3.1 Ambient or Chemical-Specific Requirements

Ambient or chemical-specific requirements set health- or risk-based concentration limits in various environmental media for specific hazardous substances or pollutants. These requirements set protective clean-

up levels for the chemicals of concern in the designated media, or indicate a safe level of air emission or wastewater discharge.

Chemical-specific ARARs are derived primarily from Federal and state health and environmental statutes and regulations. Health Effects Assessments, Health Advisories, Chemical Advisories, and Guidance Documents may also be considered when establishing clean-up standards, but are not considered to be ARARs. These and any proposed standards are classified as items to be considered, or TBCs. Where background concentrations for constituents are above the chemical-specific ARAR for that constituent, a variance from the ARAR is appropriate. A summary of potential chemical-specific ARARs for the contaminants found in ground water and surface water at Operable Unit 2 are presented in Tables 3-1.1 through 3-1.4. Table 3-1.1 presents potential ARARs for organics, Table 3-1.2 presents potential ARARs for metals, Table 3-1.3 presents potential ARARs for conventional pollutants, and Table 3-1.4 presents potential ARARs for radionuclides. When more than one potential chemical-specific ARAR has been identified for a contaminant, a screening process has been used to determine the specific potential ARAR to be applied. This screening process involves three steps as outlined below:

1. The lowest human health or agricultural-based promulgated standard among the Safe Drinking Water Act (SDWA), Maximum Contaminant Level (MCL), and CDH ground and surface water standards is first applied (potentially applicable).
2. For a RCRA Appendix VIII constituents, in the absence of any promulgated standard in step 1 above, the most stringent RCRA Land Disposal Restriction or RCRA Subpart F limit is applied (potentially relevant and appropriate).
3. In the absence of an ARAR in steps 1 or 2 above, the most stringent of the Clean Water Act Water Quality Criteria, or the proposed CDH ground water and surface water standards is applied (TBC).

Screening for these potential ARARs is presented in Table 3-2.1 through 3-2.4. Table 3-2.1 screens potential ARARs for organics, Table 3-2.2 screens potential ARARs for metals, Table 3-2.3 screens potential ARARs for conventional pollutants, and Table 3-2.4 screens potential ARARs for radionuclides. The screening process includes consideration of both ground-water and surface-water standards because of the significant interaction of alluvial ground water and surface water in the drainages of the Rocky Flats Plant. Of the

TABLE 3-1.1
POTENTIAL CHEMICAL SPECIFIC ARARS
FOR COMPOUNDS AND ELEMENTS DETECTED ABOVE BACKGROUND
IN SURFACE WATER AT OPERABLE UNIT NO. 2

| Chemical | Maximum Con- centration in Surface Water ^a | Potential ARAR (ug/l) | Potential ARAR Reference | Comment |
|--------------------------|--|-----------------------------|---|---------|
| <u>Organic Compounds</u> | | | | |
| Vinyl Chloride | 15 | 2 | SDWA MCL | |
| Methylene Chloride | 44 | 5U | RCRA Subpart F | |
| Acetone | 130 | 50 | Land Ban Constituent, Table CCWE, 40 CFR 268 Subpart D | |
| Carbon Tetrachloride | 1005 | 5 | CDH Surface Water Drinking Water Standard | |
| 1,1 Dichloroethane | 6J | 5U | RCRA Subpart F | |
| 1,2 Dichloroethene | 56 | 5U | RCRA Subpart F | |
| 1,1 Dichloroethene | 143 | 7 | CDH Surface Water Drinking Water Standard | |
| Tetrachloroethene | -280 | 5U | CDH Surface Water, Fish and Water Ingestion Standard | |
| Trichloroethene | 2500 | 5 | CDH Surface Water, Drinking Water Standard | |

TABLE 3-1.2
POTENTIAL CHEMICAL SPECIFIC ARARS
FOR COMPOUNDS AND ELEMENTS DETECTED ABOVE BACKGROUND
IN SURFACE WATER AT OPERABLE UNIT NO. 2

| Chemical | Maximum Con- centration in Surface Water ^b (mg/L) | Potential ARAR (mg/L) | Potential ARAR Reference | Comment |
|---------------|--|-----------------------------|---|---|
| <u>Metals</u> | | | | |
| Aluminum | 28.3 | 5.0 | CDH Agriculture Standard | |
| Arsenic | 0.040 | 0.05 | CDH Surface Water; Drinking Water Standard | |
| Barium | 0.831 | 1.0 | CDH Surface Water; Drinking Water Standard | |
| Beryllium | 0.057 | 0.1 | CDH Agricultural Standard | |
| Cadmium | 0.024 | 0.01 | CDH Surface Water; Drinking Water Standard | |
| Calcium | 991 | NS | No Standard | |
| Cesium | 1.11 | 1.00U | No Standard; Background (1.00) is TBC | |
| Chromium III | 0.041 | .05 | CDH Surface Water; Drinking Water Standard | Analytical result is total chromium. |
| Chromium VI | 0.041 | .05 | CDH Surface Water; Drinking Water Standard | Analytical result is total chromium. |
| Copper | 0.066 | 0.2 | CDH Ground Water; Agriculture Standard | |

TABLE 3-1.2 (cont.)
POTENTIAL CHEMICAL SPECIFIC ARARS
FOR COMPOUNDS AND ELEMENTS DETECTED ABOVE BACKGROUND
IN SURFACE WATER AT OPERABLE UNIT NO. 2

| Chemical | Maximum Con- centration in Surface Water ^b (mg/l) | Potential ARAR (mg/l) | Potential ARAR Reference | Comment |
|-----------------------|--|-----------------------------|---|--|
| <u>Metals (cont.)</u> | | | | |
| Iron | 40.07 (3.69) | 1.0 (0.3) | CDH Surface Water; Drinking Water Standard | Analytical results are total iron; dissolved iron in parentheses |
| Lead | 0.166 | 0.05 | CDH Surface Water; Drinking Water Standard | |
| Lithium | 0.180 | 2.5 | CDH Ground Water Standard | |
| Magnesium | 136 | NS | No Standard | |
| Manganese | 3.18 (1.64) | 1.0 (0.05) | CDH Surface Water; Drinking Water Standard | Analytical results are total manganese; dissolved manganese in parentheses |
| Mercury | 0.0007 | 0.002 | CDH Surface Water; Drinking Water Standard | |
| Molybdenum | 0.114 | 0.1 | CDH Ground Water; Agriculture Standard | |
| Nickel | 0.065 | 0.2 | CDH Ground Water Agriculture Standard | |
| Potassium | 31 | NS | No Standard | |
| Selenium | 0.013 | 0.01 | CDH Surface Water; Drinking Water Standard | |

TABLE 3-1.2 (cont.)
 POTENTIAL CHEMICAL SPECIFIC ARARS
 FOR COMPOUNDS AND ELEMENTS DETECTED ABOVE BACKGROUND
 IN SURFACE WATER AT OPERABLE UNIT NO. 2

| Chemical | Maximum Con- centration in Surface Water ^b (mg/l) | Potential ARAR (mg/l) | Potential ARAR Reference | Comment |
|-----------------------|--|-----------------------------|---|--------------------|
| <u>Metals (cont.)</u> | | | | |
| Sodium | 405 | NS | No Standard | Background is TBC. |
| Strontium | 2.27 | NS | No Standard | |
| Vanadium | 0.113 | 0.1 | CDH Ground Water; Agriculture Standard | |
| Zinc | 2.84 | 2.0 | CDH Ground Water; Agriculture Standard | |

TABLE 3-1.3
POTENTIAL CHEMICAL SPECIFIC ARARS
FOR COMPOUNDS AND ELEMENTS DETECTED ABOVE BACKGROUND
IN SURFACE WATER AT OPERABLE UNIT NO. 2

| Chemical | Maximum Con- centration in Surface Water ^b (mg/l) | Potential ARAR (mg/l) | Potential ARAR Reference | Comment |
|-------------------------------------|--|-----------------------------|--------------------------------|---|
| <u>Conventional Pollutants</u> | | | | |
| Nitrite | 24 | 1.0 | CDH Surface Water Standard | Analytical results are total nitrate plus nitrate nitrogen. Reanalysis re- quired to determine if nitrite potential ARAR is exceeded |
| Nitrate | 24 | 10.0 | CDH Surface Water Standard | Analytical results are total nitrate nitrogen. |
| Chloride | 170 | 250 | CDH Surface Water Standard | |
| Sulfate | 228 | 250 | CDH Surface Water Standard | |
| Bicarbonate as CaCO ₃ | 642 | NS | No Standard | |
| T.D.S. | 790 | 400 | CDH Ground Water Standard | |

TABLE 3-1.4
POTENTIAL CHEMICAL SPECIFIC ARARS
FOR COMPOUNDS AND ELEMENTS DETECTED ABOVE BACKGROUND
IN SURFACE WATER AT OPERABLE UNIT NO. 2

| Chemical | Maximum Con- centration in Surface Water ^b (mg/L) | Potential ARAR (mg/L) | Potential ARAR Reference | Comment |
|---------------------------|--|-----------------------------|--------------------------------|---------|
| <u>Radionuclides</u> | | | | |
| Gross Alpha | 310 | 7 (11)* | CDH Ground Water Standard | |
| Gross Beta | 340 | 5 (19) | CDH Surface Water Standard | |
| Pu ^{238,239,240} | 60 | .05 (.05) | CDH Surface Water Standard | |
| Am ²⁴¹ | 28 | .05 (.05) | CDH Surface Water Standard | |
| H ³ | 1100 | 500 (500) | CDH Surface Water Standard | |
| Sr ^{89,90} | 3.6 | 8 | CDH Surface Water Standard | |
| Uranium ^{total} | 23.6 | 5 (10) | CDH Surface Water Standard | |

(a) - Maximum compound concentrations determined from all available data (see Appendix A).
(b) - Total concentration unless specified; does not include outliers (see Section 3.3).
U - Detection limit
J - Estimated below detection limit
B - Compound also present in blank
TBC - To be considered
(c) - Below minimum detectable activity (MDA)
* - Value is for Woman Creek; value in parentheses is for Walnut Creek

TABLE 3-2.1
SCREENING OF CHEMICAL SPECIFIC POTENTIAL ARARS
PERTINENT TO SURFACE WATER OPERABLE UNIT 2 IN/IRA OPTIONS

| Chemical | RCRA Subpart F Concentration Limit ^a (ug/l) | CDH Ground Water Quality Standards ^b (ug/l) | SDWA Maximum Contaminant Level (MCL) ^c (ug/l) | For Use In Special Circumstances SDWA/MCL ^d (ug/l) | RCRA Land Disposal Restrictions (ug/l) ^e | CWA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (ug/l) | CDH Surface Water Quality Standards ^e (ug/l) | ARAR (ug/l) | Comment |
|--------------------------|--|--|--|---|---|---|---|-------------|--|
| Organic Compounds | | | | | | | | | |
| Carbon Tetrachloride | 5U | 5 | 5 | 0 | 50 | 35,000 ^f | 5 | 5 | CDH Surface Water Drinking Water Standard is applicable |
| 1,2 Dichloroethene | 5U | - | - | - | - | 11,000 ^f | - | 5U | RCRA Subpart F is R&A |
| 1,1 Dichloroethane | 5U | - | - | - | - | - | - | 5U | RCRA Subpart F is TBC |
| 1,1 Dichloroethene | 5U | 7 | 7 | 7 | - | 11,000 ^f | 7 | 7 | CDH Surface Water; Drinking Water Standard is applicable |
| Tetrachloroethene | 5U | 0.8 | - | 0 ^f | 79 | 5,208/840 ^f | 0.8 | 5U | CDH Surface Water; Fish and Water Ingestion Standard (0.8 ug/l) is BDL, so detection limit of 5 ug/l is applicable |
| Acetone | 100U ^h | - | - | - | 50 | - | - | 50 | RCRA LDR is relevant and appropriate |
| Methylene Chloride | 5U | - | - | - | 200 | - | - | 5U | RCRA Subpart F is R&A |

TABLE 3-2.1 (cont.)
SCREENING OF CHEMICAL SPECIFIC POTENTIAL ARARS
PERTINENT TO SURFACE WATER OPERABLE UNIT 2 IN/IRA OPTIONS

| Chemical | RCRA Subpart F Concentration Limit ^a (ug/l) | CDH Ground Water Quality Standards ^b (ug/l) | SDWA Maximum Contaminant Level (MCL) ^c (ug/l) | For Use In Special Circumstances SDWA/MCLG ^d (ug/l) | RCRA Land Disposal Restrictions (ug/l) ^e | CWA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (ug/l) | CDH Surface Water Quality Standards ^f (ug/l) | ARAR (ug/l) | Comment |
|----------------------------------|--|--|--|--|---|---|---|-------------|--|
| Organic Compounds (cont.) | | | | | | | | | |
| Trichloroethene | 50 | 5 | 5 | 0 | 62 | 45,000/21,000 ^f | 5 | 5 | CDH Surface Water; Drinking Water Standard is applicable |
| Vinyl Chloride | 100 | 2 | 2 | 0 ^f | | | | 2 | SDWA MCL and CDH ground-water quality standard is applicable |

- (a) - 40 CFR Part 264.92 Subpart F releases from solid waste management units. (40 CFR 261, Appendix VIII, List of Hazardous Constituents)
- (b) - 5 CCR 1002-8, Section 3.11.5, Basic Standards for Ground Water August 17, 1989.
- (c) - 40 CFR Part 141.61 National Primary Drinking Water Standards.
- (d) - 40 CFR Part 141.50 National Primary Drinking Water Standards.
- (e) - 5 CCR 1002-8, Section 3.8.29, Final Rule Effective March 30, 1990.
- (f) - Lowest observed effect level.
- (g) - 40 CFR Part 268.41 Subpart D - Treatment Standards.
- (h) - RCRA 40 CFR 264, Appendix IX Ground Water Monitoring List Substance Not Included in 40 CFR 261, Appendix VIII, List of Hazardous Constituents
- ARAR - Applicable or relevant and appropriate requirements
- BDL - Below detection limits
- CDH - Colorado Department of Health
- LDR - Land disposal restrictions
- MCL - Maximum contaminant level
- MCLG - Maximum contaminant level goal
- RCRA - Resource Conservation and Recovery Act
- SDWA - Safe Drinking Water Act
- TBC - To be considered
- U - Detection Limit

TABLE 3-2.2 (cont.)
SCREENING OF CHEMICAL SPECIFIC POTENTIAL ARARS
PERTINENT TO SURFACE WATER OPERABLE UNIT 2 IN/IRA OPTIONS

| Chemical | RCRA Subpart F Concentration Limit ^a (mg/l) | CDH Ground Water Standard Human Health/ Agriculture ^b (mg/l) | SDWA Maximum Contaminant Level (MCL) ^c (mg/l) | For Use in Special Circumstances SDWA/MCLG (mg/l) | CWA Ambient Water Quality Criteria for Protection of Aquatic Life | | CDH Surface Water Quality Standard ^d Drinking Water/ Agriculture (mg/l) | ARAR (mg/l) | Comment |
|-----------------------|--|--|--|--|---|--------------------------------------|---|-------------|--|
| | | | | | Freshwater Acute/Chronic (mg/l) | | | | |
| Metals (cont.) | | | | | | | | | |
| Sodium | - | - | - | - | - | - | - | NS | No Standard |
| Strontium | - | - | - | - | - | - | - | NS | Background is TBC |
| Vanadium | 0.024 | /0.1 | - | - | - | - | - | 0.1 | CDH Agriculture Standard is applicable |
| Zinc | 0.0517 ^j | 5.0/2.0 | 5.0 | - | - | 0.32 ^h /0.04 ^h | 5.0/2.0 | 2.0 | CDH Agriculture Standard is applicable |

(a) - 40 CFR Part 264.92 Subpart F Releases from solid waste management units

(b) - 5 CCR 1002-8, Section 3.11.5, Ground Water Quality Standards

(c) - 40 CFR Part 141.11 National Primary Drinking Water Standards

(d) - 5 CCR 1002-8, Section 3.8.29, Final Rule Effective March 30, 1990 (Total Recoverable Concentrations)

(f) - Proposed value as of October 1986

(g) - Lowest Observed Effect Level

(h) - Hardness dependent criteria (100 mg/l)

(j) - RCRA 40 CFR 264, Appendix IX, Ground Water Monitoring List Substance not Included in 40 CFR 261, Appendix VIII, List of Hazardous Constituents

ARAR - Applicable or relevant and appropriate

CDH - Colorado Department of Health

CWA - Clean Water Act

MCL - Maximum Contaminant Level

MCLG - Maximum Contaminant Level Goal

NS - No standard

R&A - Relevant and Appropriate

RCRA - Resource Conservation and Recovery Act

SDWA - Safe Drinking Water Act

TABLE 3-2.2 (cont.)
SCREENING OF CHEMICAL SPECIFIC POTENTIAL ARARs
PERTINENT TO SURFACE WATER OPERABLE UNIT 2 IM/IRA OPTIONS

| Chemical | RCRA Subpart F Concentration Limit ^a (mg/l) | CDH Ground Water Standard Human Health/ Agriculture ^b (mg/l) | SDWA Maximum Contaminant Level (MCL) ^c (mg/l) | For Use In Special Circumstances SDWA/MCLG (mg/L) | AWA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (mg/L) | CDH Surface Water Quality Standard ^d Drinking Water/ Agriculture (mg/l) | ARAR (mg/L) | Comment |
|-----------------------|---|---|---|---|---|---|----------------|---|
| Metals (cont.) | | | | | | | | |
| Iron | - | 0.3/5.0 | 0.3 | - | - | 0.3/ | 0.3 | CDH Surface Water; Drinking Water Standard is applicable |
| Lead | 0.05 | 0.05/0.1 | 0.05 | 0.002 ^f | .0082 ^h /.0032 | 0.05/0.1 | 0.05 | CDH Surface Water; Drinking Water Standard is applicable; |
| Lithium | - | 2.5 | - | - | - | - | 2.5 | CDH Ground Water Standard is applicable |
| Magnesium | - | - | - | - | - | - | NS | No Standard |
| Manganese | - | 0.05/0.2 | 0.05 | - | - | 0.05/0.2 | 0.05 | CDH Surface Water; Drinking Water Standard is applicable |
| Mercury | 0.002 | 0.002/0.01 | 0.002 | 0.003 | .0024/.000012 | 0.002 | 0.002 | CDH Surface Water; Drinking Water Standard is applicable |
| Molybdenum | - | /0.1 | - | - | - | - | 0.1 | CDH Agriculture Standard is applicable |
| Nickel | 0.0185 | /0.20 | - | - | 1.8 ^h /.096 ^h | 0.2 | 0.2 | CDH Agriculture Standard is applicable |
| Potassium | - | - | - | - | - | - | NS | No Standard |
| Selenium | 0.01 | 0.01/0.02 | 0.01 | 0.045 ^f | 0.26/0.35 | 0.01/0.02 | 0.01 | CDH Surface Water; Drinking Water Standard is applicable |

TABLE 3-2.2
SCREENING OF CHEMICAL SPECIFIC POTENTIAL ARARS
PERTINENT TO SURFACE WATER OPERABLE UNIT 2 IM/IRA OPTIONS

| Chemical | RCRA Subpart F Concentration Limit ^a (mg/L) | CDH Ground Water Standard Human Health/ Agriculture ^b (mg/L) | SDWA Maximum Contaminant Level (MCL) ^c (mg/L) | For Use In Special Circumstances SDWA/MCLG (mg/L) ^d | EPA Ambient Water Quality Criteria for Protection of Aquatic Life Freshwater Acute/Chronic (mg/L) | CDH Surface Water Quality Standard ^e Drinking Water/ Agriculture (mg/L) | ARAR (mg/L) | Comment |
|---------------|---|---|---|--|---|---|----------------|--|
| Metals | | | | | | | | |
| Aluminum | - | /5.0 | - | - | - | - | 5.0 | CDH Agriculture Standard is applicable |
| Arsenic | 0.05 | 0.05/0.1 | 0.05 | - | 0.8 ^g /0.48 ^g | 0.05/0.1 | 0.05 | CDH Surface Water; Drinking Standard is applicable |
| Barium | 1.0 | 1.0/ | 1.0 | 1.5 ^f | - | - | 1.0 | CDH Surface Water; Drinking Water Standard is applicable |
| Beryllium | 0.005U | /0.1 | - | - | 0.1 ^g /0.0033 ^g | /0.1 | 0.1 | CDH agricultural standard is applicable |
| Cadmium | 0.01 | 0.01/0.01 | 0.01 | 0.005 | 0.0039 ^h /0.0011 ^h | 0.01/0.01 | 0.01 | CDH Surface Water; Drinking Water Standard is applicable |
| Calcium | - | - | - | - | - | - | NS | No Standard |
| Cesium | - | - | - | - | - | - | NS | No Standard |
| Chromium III | 0.05 (tot) | 0.05/0.1 | - | - | 1.7 ^h /0.2 ^h | 0.05/0.1 | 0.05 | CDH Surface Water; Drinking Water Standard is applicable |
| Chromium VI | 0.05 (tot) | 0.05/0.1 | 0.05 | 0.0012 | 0.016/0.011 | 0.05/0.1 | 0.05 | CDH Surface Water; Drinking Water Standard is applicable |
| Copper | 0.046 | 1.0/0.2 | 1.0 | 1.3 ^f | 0.018 ^h /0.012 ^h | 1.0/0.2 | 0.2 | CDH Agriculture Standard is applicable |

the high side which is likely to be unrepresentative of the actual condition. Dixon's Test at the 95% confidence level was used to determine outliers. These outliers are shown in Table 3-4 for information purposes.

In review of Table 3-3, it can be seen that a number of organic and inorganic analytes occur above proposed ARAR at the various stations or groups of stations. The flow weighted average of the averages and maximums at the stations or groups of stations also indicates some of these constituents may exceed potential ARAR in the influent to the treatment system. The following observations and assessments are made with regard to Table 3-3:

1. There are a host of volatile organic compounds present, some of which are known carcinogens. Treatment to achieve potential ARARs for these constituents is a primary goal of the IM/IRA.
2. Plutonium, americium, and uranium, in both dissolved and total concentrations exceed potential ARAR. It is both prudent in terms of keeping activated carbon, if selected for treatment, from becoming radioactive, and in mitigating potential NPDES discharge problems at Pond B-5, that these radionuclides be removed to achieve potential ARAR.
3. A number of metals exceed potential ARAR (or TBC) in terms of total or dissolved concentrations. These metals include aluminum, iron, manganese, strontium, and to a lesser extent beryllium, cesium, molybdenum, selenium, and zinc. It is proposed that these ARARs be met only to the extent practicable for the following reasons:
 - a. Most of the aluminum, iron and manganese exist as particulates (dissolved aluminum does not exceed ARAR in the projected influent quality) and will be largely removed during suspended solids removal, a planned pretreatment process to protect downstream unit processes from fouling. For iron, and to a lesser extent manganese, this will achieve compliance with potential ARARs. Dissolved manganese will be removed to some extent by activated carbon (adsorption), air stripping (oxidation/precipitation), or UV peroxide (oxidation/precipitation), but there will be uncertainty as to the overall effectiveness of the removal process. The removal of these metals through suspended solids removal, or by other mechanisms in downstream unit processes designed for organics removal, is certain to mitigate non-compliance problems for the discharge at Pond B-5. Furthermore, iron and manganese ARARs are secondary drinking water standards (adopted as surface water standards for Walnut Creek), and are thus established for aesthetic purposes rather than for minimizing risks to the public health. Adding a unit process for the removal of these metals (and the others discussed below) will add to the cost, complexity of operation, and implementation time for the IM/IRA.
 - b. The standard for strontium is exceeded; however, the standard for strontium is TBC. Strontium is not a RCRA Appendix VIII hazardous constituent, and background has been used to establish TBC. Strontium will not significantly exceed background if not removed from the influent, and there is no surface water standard for Walnut Creek for this metal.
 - c. Beryllium, cesium, and molybdenum are unlikely to exceed potential ARARs in the influent to the treatment system due to mixing of all surface water station flows. Surface water standards for these metals are not established for Walnut Creek, therefore if these metals are not removed, there will not be a NPDES non-compliance problem at Pond B-5.

TABLE 3-4
ROCKY FLATS PLANT
SURFACE WATER DATA - DIXON TEST OUTLIERS*

| <u>SURFACE WATER STATION</u> | <u>SAMPLE DATE</u> | <u>OUTLIER CONCENTRATION</u> |
|------------------------------|--------------------|---|
| 903 Pad and Lip Area: | | |
| SW-55 | 10/19/89 | [Li] _{total} = 3.2 mg/l |
| SW-55 | 05/25/89 | [Am] _{total} = 7.2 mg/l |
| SW-55 | 06/28/89 | [Pb] _{total} = 0.0576 mg/l |
| SW-55 | 06/28/89 | [Sn] _{total} = 0.141 mg/l |
| SW-77 | 06/27/89 | [Nitrate & Nitrite] = 24 mg/l |
| Upper South Walnut Creek: | | |
| SW-56 | 04/13/89 | [Be] _{dissolved} = 0.0053 mg/l |
| SW-56 | 04/13/89 | [Acetone] = 130 µg/l |
| SW-59 | 07/06/89 | [Li] _{total} = 2.56 mg/l |
| SW-59 | 07/06/89 | [Zn] _{total} = 2.66 mg/l |
| SW-59 | 05/11/89 | [Am] _{total} = 1.3 pCi/l |
| SW-60 | 08/03/89 | TDS = 3300 mg/l |
| SW-101 | 05/11/89 | [Ba] _{total} = 2.02 mg/l |
| SW-101 | 05/11/89 | [Cr] _{total} = 0.212 mg/l |
| SW-101 | 05/11/89 | [Co] _{total} = 0.132 mg/l |
| SW-101 | 05/11/89 | [Cu] _{total} = 0.293 mg/l |
| SW-101 | 05/11/89 | [Fe] _{total} = 204 mg/l |
| SW-101 | 05/11/89 | [Pb] _{total} = 0.215 mg/l |
| SW-101 | 05/11/89 | [Mn] _{total} = 3.68 mg/l |
| SW-101 | 05/11/89 | [Mo] _{total} = 0.174 mg/l |
| SW-101 | 05/11/89 | [Hg] _{total} = 0.0024 mg/l |
| SW-101 | 05/11/89 | [Ni] _{total} = 0.246 mg/l |
| SW-101 | 05/11/89 | [V] _{total} = 0.555 mg/l |

TABLE 3-4 (cont.)

ROCKY FLATS PLANT
SURFACE WATER DATA - DIXON TEST OUTLIERS*

| <u>SURFACE WATER STATION</u> | <u>SAMPLE DATE</u> | <u>OUTLIER CONCENTRATION</u> |
|-----------------------------------|--------------------|--|
| Upper South Walnut Creek (cont.): | | |
| SW-101 | 05/11/89 | [Gross Alpha] _{total} = 780 pCi/l |
| SW-101 | 05/11/89 | [Gross Beta] _{total} = 570 pCi/l |
| SW-101 | 05/11/89 | [Pu] _{total} = 3.3 pCi/l |
| SW-101 | 05/11/89 | [Be] _{total} = 0.0572 mg/l |
| SW-101 | 05/11/89 | [Cd] _{total} = 0.0142 mg/l |
| Other Stations: | | |
| SW-53 | 08/15/89 | [Fe] _{dissolved} = 8.54 mg/l |
| SW-53 | 06/26/89 | [Fe] _{total} = 22.30 mg/l |
| SW-53 | 09/20/89 | [Sb] _{dissolved} = 0.133 mg/l |
| SW-53 | 06/26/89 | [Be] _{total} = 0.0055 mg/l |
| SW-53 | 06/23/88 | [Pb] _{total} = 0.0623 mg/l |
| SW-53 | 06/26/89 | [Sn] _{total} = 0.109 mg/l |
| SW-64 | 07/07/88 | [Al] _{total} = 15.4 mg/l |
| SW-64 | 07/07/88 | [Fe] _{total} = 17.1 mg/l |
| SW-64 | 06/27/89 | [Carbon Disulfide] = 6 µg/l |
| SW-103 | 03/23/89 | [Al] _{total} = 169 mg/l |
| SW-103 | 03/23/89 | [Ba] _{total} = 4.23 mg/l |
| SW-103 | 03/23/89 | [Cr] _{total} = .172 mg/l |
| SW-103 | 03/23/89 | [Co] _{total} = .224 mg/l |
| SW-103 | 03/23/89 | [Cu] _{total} = .213 mg/l |
| SW-103 | 03/23/89 | [Fe] _{total} = 142 mg/l |
| SW-103 | 03/23/89 | [Pb] _{total} = .656 mg/l |
| SW-103 | 03/23/89 | [Mg] _{total} = 56.8 mg/l |

TABLE 3-4 (cont.)

ROCKY FLATS PLANT
SURFACE WATER DATA - DIXON TEST OUTLIERS*

| <u>SURFACE WATER STATION</u> | <u>SAMPLE DATE</u> | <u>OUTLIER CONCENTRATION</u> |
|------------------------------|--------------------|-------------------------------------|
| Other Stations (cont.): | | |
| SW-103 | 03/23/89 | [Mn] _{total} = 10.7 mg/l |
| SW-103 | 03/23/89 | [Ni] _{total} = .273 mg/l |
| SW-103 | 03/23/89 | [V] _{total} = .445 mg/l |
| SW-103 | 03/23/89 | [Be] _{total} = 0.0214 mg/l |
| SW-103 | 03/23/89 | [Cd] _{total} = 0.0241 mg/l |
| SW-103 | 06/15/89 | [Pb] _{total} = 0.116 mg/l |

* The concentration data listed in Table 2 were identified as outliers by Dixon's Test at a 95% confidence level. Dixon's Test is a statistical procedure for determining the probability that datum would be observed if the data were normally distributed.

Dixon, W.J., 1953. Processing Data Outliers, Biometrics, v. 9, pp. 74-89.

- d. The TDS potential ARAR may be exceeded at times; however, the TDS potential ARAR is a ground water protection standard, not a Walnut Creek in-stream standard. Again, the ground-water protection standard is a secondary drinking water standard established for aesthetic purposes, not for the protection of the public health.

Lastly, it is noted that treatment for organics and radionuclides removes greater than 99% of the risk to the public health (see the Environmental Assessment for the 881 Hillside IM/IRA). It is also hypothesized in the Phase II RFI/RIFS Plan for Operable Unit No. 2, with reasonable confidence, that the above background metals and inorganics in ground water at Operable Unit No. 2, including uranium, is due to localized evaporative concentration. If such a natural phenomenon explains the apparently elevated concentrations of these constituents, treatment for their removal would be a futile and costly attempt at cleaning up the natural environment. Because an interim action need not meet all ARARs, it is logical that the potential ARARs established for the above noted constituents be met only to the extent practicable.

3.3.2 Locational Requirements

Locational requirements are statutes or regulations which set restrictions on activities or limits on contaminant levels, depending on the characteristics of a site or its immediate environs. Examples of locational requirements are Federal and state citing laws for hazardous waste facilities, or sites on the National Register of Historic Places. Also included are the Wilderness Protection Act and floodplain regulations promulgated pursuant to the Federal Emergency Management Agency's National Flood Insurance Program. Location-specific ARARs that are potentially relevant and appropriate are the State of Colorado citing criteria for RCRA treatment units, and for surface-water discharges, the CDH Water Quality Division's regulations pertaining to pre-approval of treatment facility location.

3.3.3 Performance, Design, or Other Action-Specific Requirements

Performance, design, or other action-specific requirements set controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants. These requirements are not triggered by the specific chemicals present at a site, but rather by the particular IM/IRA alternatives that are evaluated as part of this plan. Action-specific ARARs are technology-based performance standards, such as

the Best Available Technology (BAT) standard of the Federal Water Pollution Control Act. Other examples include RCRA treatment, storage, and disposal standards, and Clean Water Act pretreatment standards for discharges to publicly-owned treatment works (POTWs). Potential action specific ARARs for the interim remedial actions evaluated here are included in Table 3-5.

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TABLE 3-5
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| Action | Requirement | Prerequisite | Citation | ARAR | Comments |
|-----------|--|---|---|------------|--|
| Treatment | BDAT standards for spent solvent wastes and dioxin-containing wastes are based on one of four technologies or combinations; for waste waters, (1) steam stripping, (2) biological treatment, or (3) carbon absorption (alone or in combination with (1) or (2)); and for all other wastes, incineration. Any technology may be used, however, if it will achieve the concentration levels specified. | Effective November 8, 1988, disposal of contaminated soil or debris resulting from CERCLA response actions or RCRA corrective actions is subject to land disposal prohibitions and/or treatment standards established for spent solvent wastes, dioxin-containing wastes, and "California list" wastes. | RCRA Sections 3004(d)(3), (e)(3) 42 U.S.C. 6924(d)(3), (e)(3) | Applicable | Movement of excavated soil on-site or transportation of soil off-site for disposal must be treated to attain levels achievable by best demonstrated available treatment technologies before being land-disposed. |
| Capping | Placement of a cap over waste (e.g., closing a landfill, or closing a surface impoundment or waste pile as a landfill, or similar action) requires a cover designed and constructed to: | RCRA hazardous waste placed at site after November 19, 1980, or movement of hazardous waste from one unit, area of contamination, or location into another unit or area of contamination will make requirements applicable. Capping without such movement will not make requirement applicable, but technical requirements are likely to be relevant and appropriate. | 40 CFR 264.258(b) 40 CFR 264.310(g) | R&A | Capping of waste in place using RCRA technical requirements R&A |

- Provide long-term minimization migration of liquids through the capped area;
- Function with minimum maintenance;
- Promote drainage and minimize erosion or abrasion of the cover;
- Accommodate settling and subsidence so that the cover's integrity is maintained; and
- Have a permeability less than or equal to the permeability of any bottom liner system or natural sub-soils present.

TABLE 3-5
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| Action | Requirement | Prerequisites | Citation | ARAR | Comments |
|-----------|---|--|--|------------|---|
| Treatment | <p>BDAT standards for spent solvent wastes and dioxin-containing wastes are based on one of four technologies or combinations; for waste waters, (1) steam stripping, (2) biological treatment, or (3) carbon absorption (alone or in combination with (1) or (2)); and for all other wastes, incineration. Any technology may be used, however, if it will achieve the concentration levels specified.</p> | <p>Effective November 8, 1988, disposal of contaminated soil or debris resulting from CERCLA response actions or RCRA corrective actions is subject to land disposal prohibitions and/or treatment standards established for spent-solvent wastes, dioxin-containing wastes, and "California List" wastes.</p> | <p>RCRA Sections 3004(d)(3), (e)(3) 42 U.S.C. 6924(d)(3), (e)(3)</p> | Applicable | <p>Movement of excavated soil on-site or transportation of soil off-site for disposal must be treated to attain levels achievable by best demonstrated available treatment technologies before being land-disposed.</p> |
| Capping | <p>Placement of a cap over waste (e.g., closing a landfill, or closing a surface impoundment or waste pile as a landfill, or similar action) requires a cover designed and constructed to:</p> <ul style="list-style-type: none"> • Provide long-term minimization migration of liquids through the capped area; • Function with minimum maintenance; • Promote drainage and minimize erosion or abrasion of the cover; • Accommodate settling and subsidence so that the cover's integrity is maintained; and • Have a permeability less than or equal to the permeability of any bottom liner system or natural sub-soils present. | <p>RCRA hazardous waste placed at site after November 19, 1980, or movement of hazardous waste from one unit, area of contamination, or location into another unit or area of contamination will make requirements applicable. Capping without such movement will not make requirement applicable, but technical requirements are likely to be relevant and appropriate.</p> | <p>40 CFR 264.258(b) 40 CFR 264.310(a)</p> | R&A | <p>Capping of waste in place using RCRA technical requirements R&A</p> |

TABLE 3-5 (cont.)
SCREENING OF PROBABLE ACTION SPECIFIC ARARs
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| <u>Action</u> | <u>Requirement</u> | <u>Prerequisite</u> | <u>Citation</u> | <u>ARAR</u> | <u>Comments</u> |
|--------------------|---|---------------------|--|-------------|-----------------|
| Capping (cont.) | <ul style="list-style-type: none"> Eliminate free liquids, stabilize wastes before capping (surface impoundments). | | 40 CFR 264.228(a) | | |
| | <ul style="list-style-type: none"> Restrict post-closure use of property as necessary to prevent damage to the cover. | | 40 CFR 264.117(c) | | |
| | <ul style="list-style-type: none"> Prevent runoff and runoff from damaging cover. | | 40 CFR 264.228(b) 40 CFR 264.310(b) | | |
| | <ul style="list-style-type: none"> Protect and maintain surveyed benchmarks used to locate waste cells (landfills, waste piles). | | 40 CFR 264.310(b) | | |
| | <ul style="list-style-type: none"> Eliminate free liquids by removal or solidification. | | 40 CFR 264.228(a)(2) | | |
| | <ul style="list-style-type: none"> Stabilization of remaining waste and waste residues to support cover. | | 40 CFR 264.228(a)(2) and 40 CFR 264.258(b) | | |
| | <p>Installation of final cover to provide long-term minimization of infiltration.</p> <p>Post-closure care and ground-water monitoring.</p> | | 40 CFR 264.310 40 CFR 264.310 | | |

TABLE 3-5 (cont.)
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| Action | Requirement | Prerequisite | Citation | ARAR | Comments |
|--------------------------|---|--|---|------|---|
| Clean Closure | General performance standard requires minimization of need for further maintenance and control; minimization or elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products. Disposal or decontamination of equipment, structures, and soils. | RCRA hazardous waste (listed or characteristic) placed at site after November 19, 1980, or movement of hazardous waste from one unit, area of contamination, or location into another unit or area of contamination. Not applicable to material undisturbed since November 19, 1980. | 40 CFR 264.111 | R&A | Applicable to soil excavated for off-site disposal. |
| | | May apply to surface impoundment; contaminated soil, including soil from dredging or soil disturbed in the course of drilling or excavation, and returned to land. | 40 CFR 264.111 | | |
| | Removal or decontamination of all waste residues, contaminated containment system components (e.g., liners, dikes), contaminated subsoils, and structures and equipment contaminated with waste and leachate, and management of them as hazardous waste. | | 40 CFR 264.228(a)(1) and 40 CFR 264.258 | | |
| | Meet health-based levels at unit. | | 40 CFR 244.111 | | |
| Excavation/Consolidation | Area from which materials are excavated may require cleanup to levels established by closure requirements. | Movement of hazardous waste (listed or characteristic) from one unit or area of contamination into another. Consolidation within a unit or area of contamination does not trigger applicability. | See Clean Closure | R&A | RCRA requirements for clean closure are R&A to remedial action involving soil excavation. |
| | Consolidation in storage piles/storage tanks will trigger storage requirements. | | | R&A | RCRA requirements for storage in waste piles or tanks are relevant and appropriate for interim storage of excavated soil destined for consolidation or off-site disposal. |

TABLE 3-5 (cont.)
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

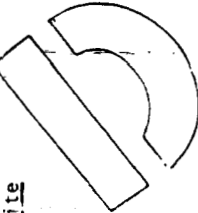
| <u>Action</u> | <u>Requirement</u> | <u>Prerequisite</u> | <u>Citation</u> | <u>ARAR</u> | <u>Comments</u> |
|---|--|--|----------------------------------|-------------|--|
| Excavation/ Consolidation (cont.) | Placement on or in land outside unit boundary or area of contamination will trigger land disposal requirements and restrictions. |  | 40 CFR 268 (Subpart D) | R&A | Soil excavated during installation of French drains is subject to land disposal restrictions for solvent containing waste. Requirements are applicable for RCRA hazardous waste; R&A if not RCRA hazardous waste. |
| Ground-Water Diversion | Excavation of soil for construction of slurry wall may trigger cleanup or land disposal restrictions. | RCRA hazardous waste placed at site after November 19, 1980, or movement hazardous waste from one unit, area of contamination, or location into another unit or area of contamination. | See Excavation/ Consolidation | R&A | See Excavation/Consolidation |
| Treatment or Storage in Tanks | Tanks must have sufficient shell strength (thickness), and, for closed tanks, pressure controls, to assure that they do not collapse or rupture. | RCRA hazardous waste (listed or characteristic), held for temporary period before treatment, disposal, or storage elsewhere, (40 CFR 264.10) in a tank. | 40 CFR 264.100 | R&A | Relevant and appropriate for treatment and storage tanks used in treating contaminated ground water. |
| | Waste must not be incompatible with the tank material unless the tank is protected by a liner or by other means. | | 40 CFR 264.191 | | |
| | New tanks or components must be provided with secondary containment. | | 40 CFR 264.193 | | |
| | Tanks must be provided with controls to prevent overflowing, and sufficient freeboard maintained in open tanks to prevent overtopping by wave action or precipitation. | | 40 CFR 264.194 | | |

TABLE 3-5 (cont.)
 SCREENING OF PROBABLE ACTION SPECIFIC ARARS
 FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| Action | Requirement | Prerequisite | Citation | ARAR | Comments |
|---|--|---|----------------|----------------|---|
| Treatment or Storage in Tanks (cont.) | Inspect the following: overfilling control, control equipment, monitoring data, waste level (for uncovered tanks), tank condition, above-ground portions of tanks, (to assess their structural integrity) and the area surrounding the tank (to identify signs of leakage). | Repair any corrosion, crack, or leak. | 40 CFR 264.195 | 40 CFR 264.196 | 40 CFR 264.197 |
| At closure, remove all hazardous waste and hazardous waste residues from tanks, discharge control equipment and discharge confinement structures. | Store ignitable and reactive waste so as to prevent the waste from igniting or reacting. Ignitable or reactive wastes in covered tanks must comply with buffer zone requirements in "Flammable and Combustible Liquids Code," Tables 2-1 through 2-6 (National Fire Protection Association, 1976 or 1981). | Containers of hazardous waste must be: | 40 CFR 264.171 | R&A | RCRA container storage requirements are R&A |
| Container Storage (On-Site) | • Maintained in good condition; | RCRA hazardous waste (listed or characteristic) held for a temporary period before treatment, disposal, or storage elsewhere, in a container (i.e., any portable device in which a material is stored, transported, disposed of, or handled) (40 CFR 264.10). | 40 CFR 264.171 | R&A | RCRA container storage requirements are R&A |

TABLE 3-5 (cont.)
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| Action | Requirement | Prerequisite | Citation | ARAR | Comments |
|--|--|--------------|---------------------------|------------|---|
| Container Storage (On-Site) (cont.) | At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers, liners. | | 40 CFR 264.178 | | |
| Off-Site Treatment Storage or Disposal | In the case of any removal or remedial action involving the transfer of any hazardous substance or pollutant or contaminant off-site, such hazardous substance or pollutant or contaminant shall only be transferred to a facility which is operating in compliance with section 3004 and 3005 of the Solid Waste Disposal Act (or where applicable, in compliance with the Toxic Substances Control Act or other applicable Federal law) and all applicable State requirements. Such substance or pollutant or contaminant may be transferred to a land disposal facility only if the President determines that both of the following requirements are met: | | SARA section 121(d)(2)(C) | Applicable | Applicable to the off-site treatment, storage, or disposal of wastes generated during on-site remedial actions. |

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- The unit to which the hazardous substance or pollutant or contaminant is transferred is not releasing any hazardous waste, or constituent thereof, into the ground water or surface water or soil.

TABLE 3-5 (cont.)
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

Comments

ARAR

Citation

Prerequisite

Requirement

Action

Off-Site
Treatment
Storage or
Disposal
(cont.)

- All such releases from other units at the facility are being controlled by a corrective action program approved by the Administrator under subtitle C of the Solid Waste Disposal Act.

Hazardous
Waste
Operation

As mandated by SARA, OSHA has promulgated regulations that require employers to develop and implement a written safety/health program designed to regulate employee safety and health during hazardous waste operations. The safety and health program must include:

- Organizations structure - Establish and implement chain of command and specify the responsibilities of key personnel.
- Comprehensive work plan - Identify anticipated activities, define work tasks, establish personnel requirements, and provide for the implementation of medical surveillance and training programs as required by these regulations.

29 CFR Part 1910.120

Regulations apply to hazardous substance response operations under CERCLA; corrective cleanup under RCRA; hazardous waste operations that have been designated for cleanup by state or local authorities; most operations involving the treatment, storage or disposal of hazardous wastes regulated under RCRA; and emergency response operations for releases or threats of releases of hazardous substances.

TABLE 3-5 (cont.)
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| <u>Action</u> | <u>Requirement</u> | <u>Prerequisite</u> | <u>Citation</u> | <u>ARAR</u> | <u>Comments</u> |
|-----------------------------------|--|---------------------|--------------------|-------------|---|
| Hazardous Waste Operation (cont.) | <ul style="list-style-type: none"> Site-Specific Health and Safety Plans - A site health and safety plan must be prepared for each phase of operation that addresses key personnel; hazard recognition; training assignments; personnel protective equipment to be used; medical surveillance; frequency and type of monitoring, including air and personal monitoring; site control measures; decontamination procedures; emergency contingency plans. | | | | |
| | General Requirements of these regulations: | | | | |
| | <ul style="list-style-type: none"> Site characterization and analysis - Identify site hazards to determine levels of personnel protection | | 29 CFR 1910.120(c) | Applicable | Site hazards have been characterized through the RI/FS process. |
| | <ul style="list-style-type: none"> Site Control - Implement site control zones to minimize employee exposure to hazardous substances. | | 29 CFR 1910.120(d) | Applicable | Site control zones will be defined in site-specific health and safety plans. |
| | <ul style="list-style-type: none"> Training - Initial training and refresher training required before employee is permitted to engage in site activities. | | 29 CFR 1910.120(e) | Applicable | Personnel engaged in remedial actions at Operable Unit 2 are required to meet minimum training requirements as specified in the OSHA standards. |

TABLE 3-5 (cont.)
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| <u>Action</u> | <u>Requirement</u> | <u>Prerequisite</u> | <u>Citation</u> | <u>ARAR</u> | <u>Comments</u> |
|-----------------------------------|---|---------------------|--------------------|-------------|--|
| Hazardous Waste Operation (cont.) | <ul style="list-style-type: none"> Medical Surveillance - Employers must implement medical surveillance for employees potentially exposed to hazardous substances. Engineering Controls, work practices and personnel protective equipment - One or all of these shall be used to minimize exposure of employees to hazardous substances and health hazards. Monitoring - Monitoring of exposures of employees to hazardous substances is required to determine the efficacy of protective equipment and engineering controls. Informational Programs - Employees, contractors, and subcontractors shall be informed of the degree and nature of hazards associated with site activities. Material Handling - Hazardous substances, contaminated soils, liquids or other residues shall be handled, transported, and labeled according to subsection (j) of the OSHA standard. | | 29 CFR 1910.120(f) | Applicable | |
| | | | 29 CFR 1910.120(g) | Applicable | |
| | | | 29 CFR 1910.120(h) | Applicable | |
| | | | 29 CFR 1910.120(i) | Applicable | All personnel involved in site activities will be required to read and comply with the site safety plan. The safety plan will outline the anticipated physical and chemical hazards. |
| | | | 29 CFR 1910.120(j) | Applicable | D.O.T. specification containers will be used to handle, store or transport. |

TABLE 3-5 (cont.)
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| <u>Action</u> | <u>Requirement</u> | <u>Prerequisite</u> | <u>Citation</u> | <u>ARAR</u> | <u>Comments</u> |
|-----------------------------------|--|---------------------|-----------------------|-------------|--|
| Hazardous Waste Operation (cont.) | <ul style="list-style-type: none"> Decontamination - Decontamination procedures outlined in subsection (k) of the standard must be complied with during on-site remedial action. Emergency Response - Contingency plans must be developed as part of site health and safety planning. Minimum Illumination/Sanitation - Minimum illumination and sanitation facilities must be provided for employees involved in hazardous waste operations. Site Excavation - Site excavations must be shored or sloped to prevent collapse. Contractors and Subcontractors - Employers must inform contractors or subcontractors of potential hazards associated with site activities. | | 29 CFR 1910.120(k) | Applicable | Decontamination procedures will be presented in the site health and safety plan. |
| | | | 29 CFR 1910.120(l) | Applicable | Contingency plans will be developed for the site health and safety plan. |
| | | | 29 CFR 1910.120(m)(n) | Applicable | |
| | | | 29 CFR 1910.120/1926 | Applicable | |
| | | | 29 CFR 1910.120 | Applicable | |

TABLE 3-5 (cont.)
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| Action | Requirement | Prerequisite | Citation | ARAR | Comments |
|--|---|--------------|---|------------|--|
| Hazardous Waste Operation (cont.) | <ul style="list-style-type: none">Permissible Exposure Levels (PEL) and Short Term Exposure Level (STEL) - OSHA establishes PELs for substances amending its Air Contaminants Standard. OSHA has reviewed health, risk, and feasibility evidence for all substances for which PELs and STELs are established. | | 29 CFR 1910.1000 | Applicable | |
| Discharge of Storm Waters | Requires storm water discharges to be permitted under the Federal (or state) National Pollution Discharge Elimination Systems (NPDES) program. Different requirements are applicable for different classes and types of discharges. | | 40 CFR 122.21(g) 40 CFR 122.26, and 40 CFR 122.28 | R&A | Applicable to the discharge of storm waters on-site. |
| Discharge of Water into Surface Water Bodies | An NPDES permit is required for discharging water into surface water bodies. | | 40 CFR 122 and 40 CFR 125 | R&A | The remedial alternatives at Operable Unit 2 may include the discharge of treated or untreated ground water. |
| Effluent | This section establishes pre- | | 40 CFR 403.5 | R&A | The remedial alternatives at Operable Unit 2 may include discharges of pre-treated ground water to POTW's. |

TABLE 3-5 (cont.)
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| <u>Action</u> | <u>Requirement</u> | <u>Prerequisite</u> | <u>Citation</u> | <u>ARAR</u> | <u>Comments</u> |
|--|--|--|-------------------------------|-------------|---|
| Discharge of Treatment System Effluent (cont.) | Use of best available technology (BAT) economically achievable is required to control toxic and non-conventional pollutants. Use of best conventional pollutant control technology (BCT) is required to control conventional pollutants. Technology-based limitations may be determined on a case-by-case basis. | | 40 CFR 122.44 | R&A | The remedial alternatives at Operable Unit 2 may include the discharge of treatment system effluent. |
| U.S. EPA Ground-Water Protection Strategy | The strategy includes guidelines on classifying ground water for EPA decisions affecting ground water protection and corrective actions. Criteria include ecological importance, replaceability, and vulnerability consideration. | The protection strategy does not involve applicable ARARs but does contain policy statements to be considered. | | TBC | This strategy is to be considered regarding ground water remedial alternatives for Operable Unit 2. |
| National Ambient Air Quality | National ambient air quality standards have been set to attain and maintain primary and secondary standards to protect public health and the environment. Requirements include a major-source permit, prevention of significant deterioration permit, non-attainable area permit, and visibility permit. | | CAA Section 109 and 40 CFR 50 | R&A | Remedial actions at Operable Unit 2 that may result in new sources of air emissions include incineration, excavation, and air stripping of contaminated ground water. |
| New Source Performance Standards | Standards for new sources of air emissions. Requirements are source-specific. | Need to determine if these standards apply to potential remedial actions. | CAA Section 111 | R&A | |

TABLE 3-5 (cont.)
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| <u>Action</u> | <u>Requirement</u> | <u>Prerequisite</u> | <u>Citation</u> | <u>ARAR</u> | <u>Comments</u> |
|---|---|---------------------|--|-------------|---|
| Transportation of Hazardous Materials | Specific DOT requirements exist for labeling, packaging, shipping papers/manifesting, and transporting by rail, aircraft, vessel, and highway. | | 49 CFR 100-199 | R&A | Applicable to wastes or materials shipped off-site. |
| Environmental Impact of Federal Actions | A statement of environmental impact is required. Establishes provisions applicable to and binding on all federal agencies for implementing the procedural requirements of the National Environmental Policy Act (NEPA). Includes procedures for planning (Part 1501), preparing environmental impact statements (Part 1502), decision-making (Part 1503), and compliance (Part 1507). | | NEPA Section 102(2)(c) and 40 CFR 1500-1508; DOE 5440.1C | R&A | |
| Worker Safety | Occupational Safety and Health program for DOE contractor employees at government-owned contractor-operated facilities. | | DOE 5483.1A | Applicable | |
| Emergency Planning, Preparedness, and Response for Operations | Provide coordination direction of planning, preparedness, and response to operational emergencies in which there is a potential for personal injury, destruction of property, theft, or release of toxic, radioactive, or other hazardous material which present a potential threat to health, safety, or the environment. | | DOE 5500.2 | Applicable | |

TABLE 3-5 (cont.)
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| <u>Action</u> | <u>Prerequisite</u> | <u>Citation</u> | <u>ARAR</u> | <u>Comments</u> |
|--|---|-----------------|-------------|-----------------|
| General Environmental Protection Program | Establishes environmental protection program requirements, authorities, and responsibilities for DOE operations for ensuring compliance with federal and state environment protection laws and regulations, federal executive orders, and internal department policies. | DOE 5400.1 | Applicable | |
| Environmental Compliance Issue Coordination | Establishes DOE requirements for coordination of significant environmental compliance issues. | DOE 5400.2A | Applicable | |
| Hazardous and Radioactive Mixed Waste Program | Establishes DOE hazards and radioactive mixed waste policies and requirements and implements RCRA. | DOE 5400.3 | Applicable | |
| Radiation Protection | Establishes radiation protection standards and requirements including occupationally related exposure of individuals in controlled areas. | DOE 5480.1 | Applicable | |
| Packaging and Transportation of Hazardous Materials, Hazardous Substances, hazardous wastes, and radioactive materials | Establishes requirements for packaging and transportation. | DOE 5480.3 | Applicable | |
| Comprehensive Environmental Response, Compensation and Liability Act Program | Establishes basic requirements for implementation of the Superfund at DOE facilities. | DOE 5480.14 | Applicable | |

TABLE 3-5 (cont.)
SCREENING OF PROBABLE ACTION SPECIFIC ARARS
FOR REMEDIAL ACTIONS AT OPERABLE UNIT 2

| <u>Action</u> | <u>Requirement</u> | <u>Prerequisite</u> | <u>Citation</u> | <u>ARAR</u> | <u>Comments</u> |
|--|---|---------------------|-----------------|-------------|-----------------|
| Environmental Protection, Safety, and Health Protection Information Reporting Requirements | Establishes requirements and procedures for reporting information having environmental protection, safety, or health significance for DOE operations. | | DOE 5484.1 | Applicable | |
| Radioactive Waste Management | Establishes policies and guidelines by which DOE manages radioactive waste, waste byproducts, and radioactively contaminated surplus facilities. | | DOE 5820.2A | Applicable | |

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SECTION 4.0

IDENTIFICATION AND ANALYSIS OF IM/IRA ALTERNATIVES

4.1 SURFACE WATER COLLECTION AND TREATMENT ALTERNATIVES

The strategy used for selecting the preferred surface water IM/IRA is to first evaluate alternative technologies for surface water collection and treatment, and subsequently to combine the preferred technologies to form the selected IM/IRA. Technologies corresponding to the following categories are evaluated in Section 4:

- Surface Water Collection;
- Treatment for Suspended Solids Removal;
- Treatment for Radionuclide Removal, and
- Treatment for Organic Constituent Removal.

The technologies selected for consideration are based on their ability to meet the objectives stated in Section 3.1, and for treatment technologies, their ability to meet the effluent requirements (Table 4-1). The screening process for critical evaluation of the collection and treatment technologies is presented in Section 4.2. The evaluation criteria include effectiveness, implementability and costs of the technology. The surface water collection and treatment technologies are presented and evaluated in detail in Sections 4.3 and 4.4, respectively.

4.1.1 Surface Water Collection Technologies

As discussed in Section 2.3.5 and shown in Figure 4-1, there are several seeps and in-stream surface water monitoring stations exhibiting organic and/or radionuclide contamination. Operable Unit No. 2 seeps include those associated with the 903 Pad and Lip Site Area (SW-50, SW-51, SW-52, SW-55, SW-57, SW-58, and SW-77), SW-53, SW-63, SW-64, and one associated with the South Walnut Creek drainage (SW-103). Contaminated surface water stations along Upper South Walnut Creek include SW-56, SW-59, SW-60, SW-61,

TABLE 4-1

BASIS FOR DESIGN OF SURFACE WATER TREATMENT PLANT

| | <u>Units</u> | <u>Influent Concentration^a</u> | <u>Effluent Requirements^b</u> |
|--------------------------------|--------------|---|--|
| <u>Organics</u> | | | |
| Vinyl Chloride | µg/l | 13 | 2 |
| Methylene Chloride | µg/l | 31 | 5 |
| 1,1-Dichloroethene | µg/l | 104 | 7 |
| 1,1-Dichloroethane | µg/l | 6 | 5 |
| 1,2-Dichloroethene (total) | µg/l | 38 | 5 |
| Carbon Tetrachloride | µg/l | 474 | 5 |
| Trichloroethene | µg/l | 378 | 5 |
| Tetrachloroethene | µg/l | 185 | 5 |
| <u>Dissolved Radionuclides</u> | | | |
| Gross Alpha | pCi/l | 15.85 | 11 |
| Gross Beta | pCi/l | 33.93 | 19 |
| Plutonium 239,240 | pCi/l | 0.18 | 0.05 |
| Total Uranium | pCi/l | 8.44 | 10 |
| <u>Total Radionuclides</u> | | | |
| Gross Alpha | pCi/l | 235 | 11 |
| Gross Beta | pCi/l | 237 | 19 |
| Plutonium 239,240 | pCi/l | 7.85 | 0.05 |
| Americium 241 | pCi/l | 0.69 | 0.05 |
| Total Uranium | pCi/l | 14.41 | 10 |

^a Based on flow weighted maximum concentrations of 903 Pad and Lip Area Seeps (SW-50, SW-51, SW-52, SW-55, SW-57, SW-58, and SW-77), SW-53, SW-63, SW-64, Upper South Walnut Creek seeps and surface water stations (SW-56, SW-59, SW-60, SW-61, SW-101), and SW-103. Averages computed from the 1987, 1988, 1989, and 1990 databases (Table 3-3) with outliers (Table 3-4) eliminated.

^b Based on chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs).

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and SW-101. Seepage originating from the 903 Pad and Lip Site Area collects at either SW-55 or SW-77. Seepage at stations SW-53, SW-63, and SW-64 are downstream and isolated sources. All seepage in this area flows towards the South Interceptor Ditch and ultimately collects in Pond C-2. Similarly, contaminated water in the upper reach of South Walnut Creek eventually flows past SW-61. This water ultimately enters Pond B-5 via Pond B-4.

Based on the foregoing discussion, the two alternatives evaluated for collecting the Operable Unit No. 2 contaminated surface water are the following:

- collect surface water by diversion at the source; and
- collect surface water from retention ponds B-5 and C-2.

Another technique for collection of water at the various seeps is ground water withdrawal. As discussed here, this technique was not considered for further detailed evaluation. By lowering the ground water table using an upgradient french drain or well array, seepage would be eliminated allowing separation of contaminated ground water (seepage) from runoff. However, the hydrology is insufficiently understood to design an effective ground water withdrawal system. For example, it is not known whether the seepage is due to water originating in the Rocky Flats Alluvium and being released to the surface through colluvium due to slope changes and/or bedrock highs, or whether the source of the water is bedrock sandstone subcropping in this vicinity. This information is critical to the design of an effective ground water withdrawal system. Furthermore, the french drain alternative at the 903 Pad Lip Site would require extensive excavation of plutonium contaminated soils with attendant worker and public health protection concerns, as well as high cost.

4.1.2 Surface Water Treatment Technologies

As discussed in Section 3.3, the primary objective of surface water treatment in the IM/IRA for Operable Unit No. 2 is removal of the volatile organic compounds and radionuclides listed in Table 3-3 to levels below their respective potential ARAR values. Treatment objectives also include reduction of concentration levels of the metals listed in Table 3-3 as well as total dissolved solids to the greatest extent practicable. The treatment technologies proposed for consideration in the IM/IRA meet these objectives.

Many treatment units suitable for removal of volatile organic compounds and radionuclides from water require that suspended solids be removed from the influent to prevent performance degradation and/or fouling. Removal of suspended solids down to the 1 μm particle size range ensures optimum treatment system performance. The two candidate influent pretreatment alternatives for removal of suspended solids considered for this IM/IRA are advanced membrane filtration, and polymer addition with contact filtration in a continuous backwash filter. Pretreatment is also a vehicle for removal of particulate radionuclides and metals, and with chemical addition, facilitates precipitation and adsorption of soluble radionuclides and metals.

Treatment alternatives for radionuclide removal considered in this plan are advanced membrane filtration and ion exchange.

Volatile organic constituent removal alternatives considered include liquid phase activated carbon adsorption, air stripping with gaseous phase activated carbon adsorption and ultraviolet (UV) peroxide oxidation.

Several treatment technologies in addition to those mentioned above exist for removal of suspended solids and inorganic constituents from an aqueous phase. For suspended solids removal, these include conventional coagulation/sedimentation and filtration, and fabric filtration. For soluble radionuclide removal, reverse osmosis and electrodialysis were considered. These have been eliminated as viable technologies for the Operable Unit No. 2 Surface Water IM/IRA. Conventional coagulation/sedimentation and filtration requires significant iron or aluminum salt addition with generation of voluminous quantities of sludge (radioactive waste). Furthermore, the water must still be filtered prior to downstream treatment for radionuclides and organics removal. Fabric filtration may be used to remove 1 μm and smaller size particulates from a liquid phase. For the influent flow and suspended solids concentrations present in surface water, the anticipated high frequency of filter media replacement presents an operational drawback. This is evident based on current filtration treatment at Pond B-5. Reverse osmosis and electrodialysis are membrane filtration technologies designed specifically for reduction of total dissolved solids. These technologies are not cost-effective for radionuclide (or trace metal) removal.

4.2 IM/IRA ALTERNATIVE SCREENING PROCESS

4.2.1 Effectiveness

The criteria for effectiveness evaluation of remedial alternatives includes protection and the use of alternatives to land disposal. Protection includes protection of the community and workers during the remedial action; threat reduction (mitigation of identified threats); determination of the length of time until protection is achieved; compliance with chemical and location-specific ARARs; compliance with criteria; advisories and guidance; description of potential exposure to residuals remaining on site; and long-term reliability for providing continued protection. The effectiveness criteria also includes use of alternatives to land disposal, thus promoting utilization of treatment or recycling; instead of land disposal.

4.2.2 Implementability

The criteria for implementability evaluation of remedial alternatives includes technical feasibility, availability, and administrative feasibility. Technical feasibility includes the ability to construct the technology; maintain its operation; compliance with action-specific ARARs; ability to meet process efficiencies or performance goals; demonstrated performance; evaluation of impact of environmental conditions; and compliance with the SARA requirement that removal actions should contribute to the efficient performance of long-term remedial action to the extent practicable. Availability includes the availability of necessary equipment, materials and personnel; availability of adequate off-site treatment, storage, and disposal capacity, if appropriate; and description of post-remedial site controls which will be required at the completion of the action. Administrative feasibility includes the likelihood of public acceptance of the alternative, including site and local concern; coordination of activities with other agencies; and ability to obtain any necessary approvals or permits.

4.2.3 Costs

The criteria for evaluation of cost of remedial alternatives includes total cost and statutory limits. Total cost includes direct capital costs, indirect capital costs, and any post-removal site control costs. Since the surface water IM/IRA at Operable Unit No. 2 is not an EPA-financed remedial action, the \$2 million statutory cost limit does not apply.

4.3 EVALUATION OF SURFACE WATER COLLECTION TECHNOLOGIES

Surface water collection technologies for the Operable Unit No. 2 IM/IRA include diversion and collection of surface water at the source, and collection from retention ponds B-5 and C-2. This section presents descriptions of each alternative including anticipated flows, and an evaluation of each alternative per the screening process presented in Section 4.2.

4.3.1 Surface Water Diversion at the Sources

4.3.1.1 Description

Figure 4-2 shows the locations of the surface water diversion and collection systems proposed in this alternative. The collection systems (CS) are denoted CS-61, CS-103, CS-55, CS-63, and CS-64. The proposed location of the surface water treatment plant is also indicated on Figure 4-2. Because of anticipated flow considerations discussed below, transport of the water from the collection systems to the treatment plant is by tanker truck for CS-53, CS-55, CS-63, and CS-64 and by pipeline for CS-61 and CS-103.

Design flow rates for surface water collection systems CS-61, CS-103, CS-55, CS-53, CS-63, and CS-64 are based on flows from stations SW-61, SW-103, SW-55 plus SW-77, SW-53, SW-63 and SW-64, respectively. Historical flow data for SW-61 is listed in Table 4-2. The data indicates two high flow events of 166 gpm and

TABLE 4-2

SURFACE WATER FLOW DATA FOR SW-61¹

| <u>Flow (GPM)</u> | <u>Date of Flow Measurement</u> |
|-------------------|---------------------------------|
| 35.9 | 07/01/88 |
| 166 | 03/20/89 |
| 9.0 | 05/15/89 |
| 9.0 | 06/09/89 |
| 9.0 | 07/06/89 |
| 4.5 | 08/03/89 |
| 18.0 | 09/11/89 |
| 4.5 | 10/03/89 |
| 4.5 | 11/06/89 |
| 0 | 12/06/89 |
| 18.0 | 02/09/90 |
| 166 | 03/12/90 |

¹ Flow data obtained from the 1988, 1989 and 1990 field investigations.

all other data below 36 gpm. Only one historical flow measurement for station SW-64 (4.5 gpm, 6/20/89) and one for SW-103 (0 gpm, 7/11/88) is available. Flow measurements for stations SW-53, SW-55, SW-63 and SW-77 were not taken prior to March 1990.

To complement the historical data and collect wet season flow data not corresponding to a major precipitation event, flow measurements at SW-61, SW-55 and SW-103 were obtained in April 1990. A cutthroat flume manufactured by Beski Water Instruments, Inc. was used to obtain the data. Flows of 37.3 gpm at SW-61, 3.0 gpm at SW-55, and 13.0 gpm at SW-103 were recorded. Surface water seep flows at SW-53, SW-63, SW-64 and SW-77 were imperceptible and quantitative measurements were not obtained.

Based on the historical data available and the April 1990 field measurements and observations, design flow rates for each of the collection systems were established. These design flow rates are presented in Table 4-3. A design flow of 0.5 gpm was assigned for those seeps observed to have imperceptible flow rates (SW-53, SW-63, and SW-77). Design flows of 38 gpm, 13 gpm, and 3.0 gpm were assigned to SW-61, SW-103, and SW-55, respectively. These flows represent an above average precipitation wet season flow not corresponding to a major storm event. The historical maximum flow of 4.5 gpm was used for SW-64.

Upper South Walnut Creek flow will be collected at the downstream station SW-61 by a new surface water diversion weir and pump station (Figure 4-3). The weir will serve to divert up to 38 gpm from the drainage. Contaminated surface water will flow from upstream of the weir through a new rock riprapped channel to a bar screen manhole where large trash is separated from the flow. This screen is of the conventional manually cleaned type and will require occasional removal of trash retained on the screen. The screened, contaminated water will then enter the raw surface water pump station manhole. The pumps installed within the manhole will be of the submersible trash-type of centrifugal configuration, arranged for rail-type mounting and removal, and will be equipped with automatic alternation and start-stop "pump down" controls. Where the inflow into the pump station manhole exceeds the pumping rate, the excess flow will return through overflow piping to the drainage way below the weir.

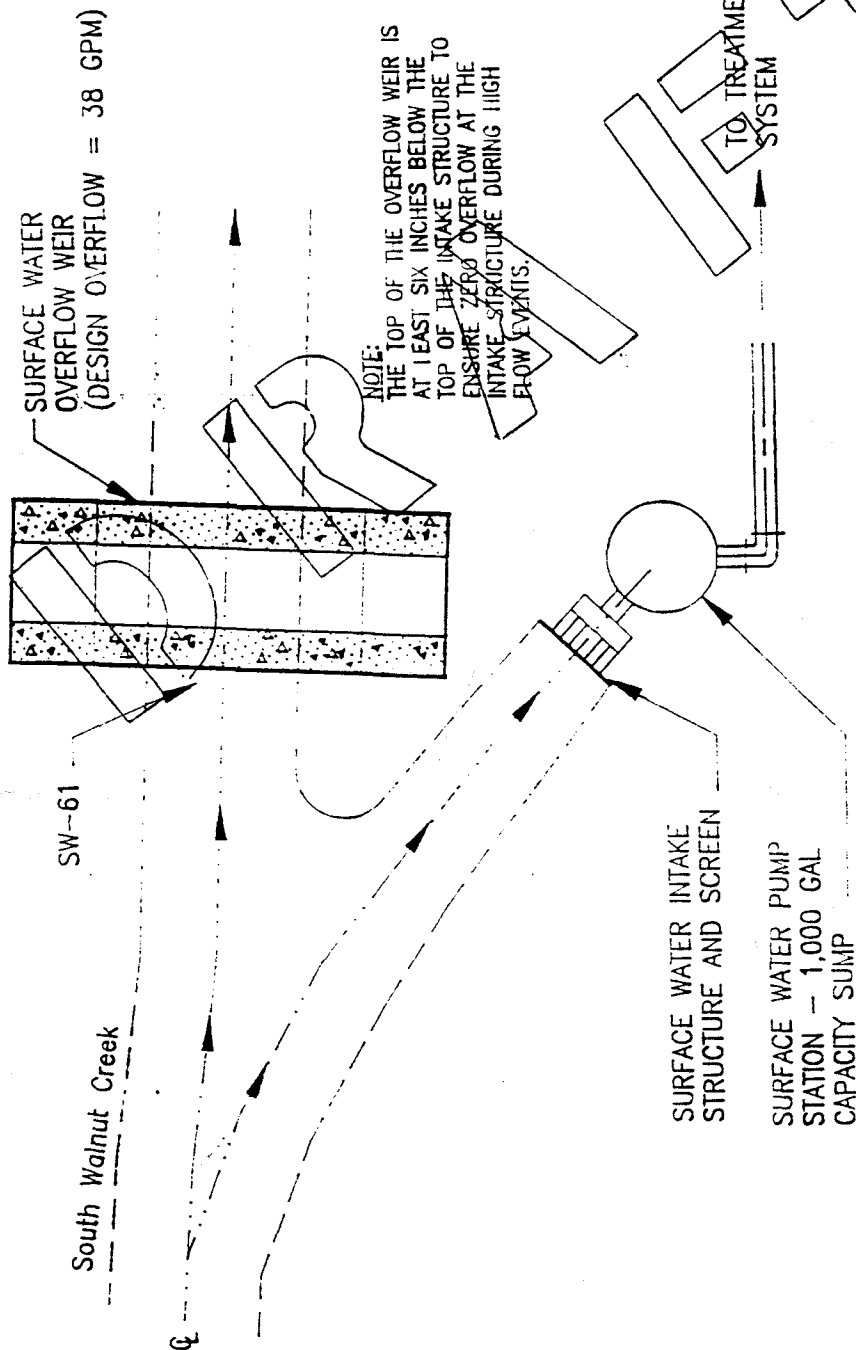


FIGURE 4-3
SURFACE WATER COLLECTION SYSTEM FOR SW-61
(PLAN VIEW)

TABLE 4-3

DESIGN FLOWS FOR SURFACE WATER
DIVERSION AND COLLECTION SYSTEM

| <u>Station</u> | <u>Maximum Flow (GPM)</u> |
|----------------|---------------------------|
| SW-53 | 0.5 |
| SW-55 | 3.0 |
| SW-61 | 38 |
| SW-63 | 0.5 |
| SW-64 | 4.5 |
| SW-77 | 0.5 |
| SW-103 | 13 |

TOTAL DESIGN FLOW

60 gpm

Design of the weir slab will include rock stabilization aprons upstream and downstream, steel sheet piling cut-off wall beneath the weir, and a shape which eliminates uplift forces during high flows. Design of the weir will be in accordance with the methods and criteria recommended in the Handbook of Applied Hydraulics, Davis and Sorensen, Section 17. Periodic removal of sediment deposited upstream of the weir will be necessary.

A diversion weir and pump station similar in design to CS-61 will be used to collect the flow from SW-103. The collection station will be located downstream of SW-103 near South Walnut Creek between Ponds B-4 and B-5. The weir will be designed to pass flows greater than 13 gpm, the previously establishes design flow rate from seep SW-103. The collected flow will be pumped from a 5000-gallon sump to the treatment facility. Upgradient flow from the Central Avenue Ditch will be diverted from crossing SW-103 by extending the Central Avenue Ditch trench to the east. This flow will be directed downgradient and reintroduced into the South Walnut Creek drainage upgradient of Pond B-5.

The 903 Pad and Lip Area seeps will be collected by CS-55, a newly installed sump at the outlet of SW-55. This collection scheme makes use of the existing surface water diversion pathways and flow described in Section 2.3.5. Installation of a riprap stabilized trench connecting SW-77 to SW-55 will allow collection of the flow from SW-77 in the sump. The sump will be a pre-casted concrete structure with a 5000-gallon capacity. A sketch of CS-55 is shown in Figure 4-4. Excavated soils will be used to construct a runoff diversion berm upslope of all seeps in this immediate vicinity.

The flow from SW-53 will be collected by a system similar to CS-55. A 5000-gallon capacity concrete sump will be located at the outlet of the existing steel culvert which directs SW-53 flow under the firing range access road. A sketch of this configuration is shown on Figure 4-4. Excavated soils will be used to construct a runoff diversion berm upslope of this seep.

Surface water seep SW-63 covers a circular area measuring approximately six feet in diameter (Figure 4-4). A half-circle shaped trench excavated downslope of the seep will be used to divert seep flow to a sump

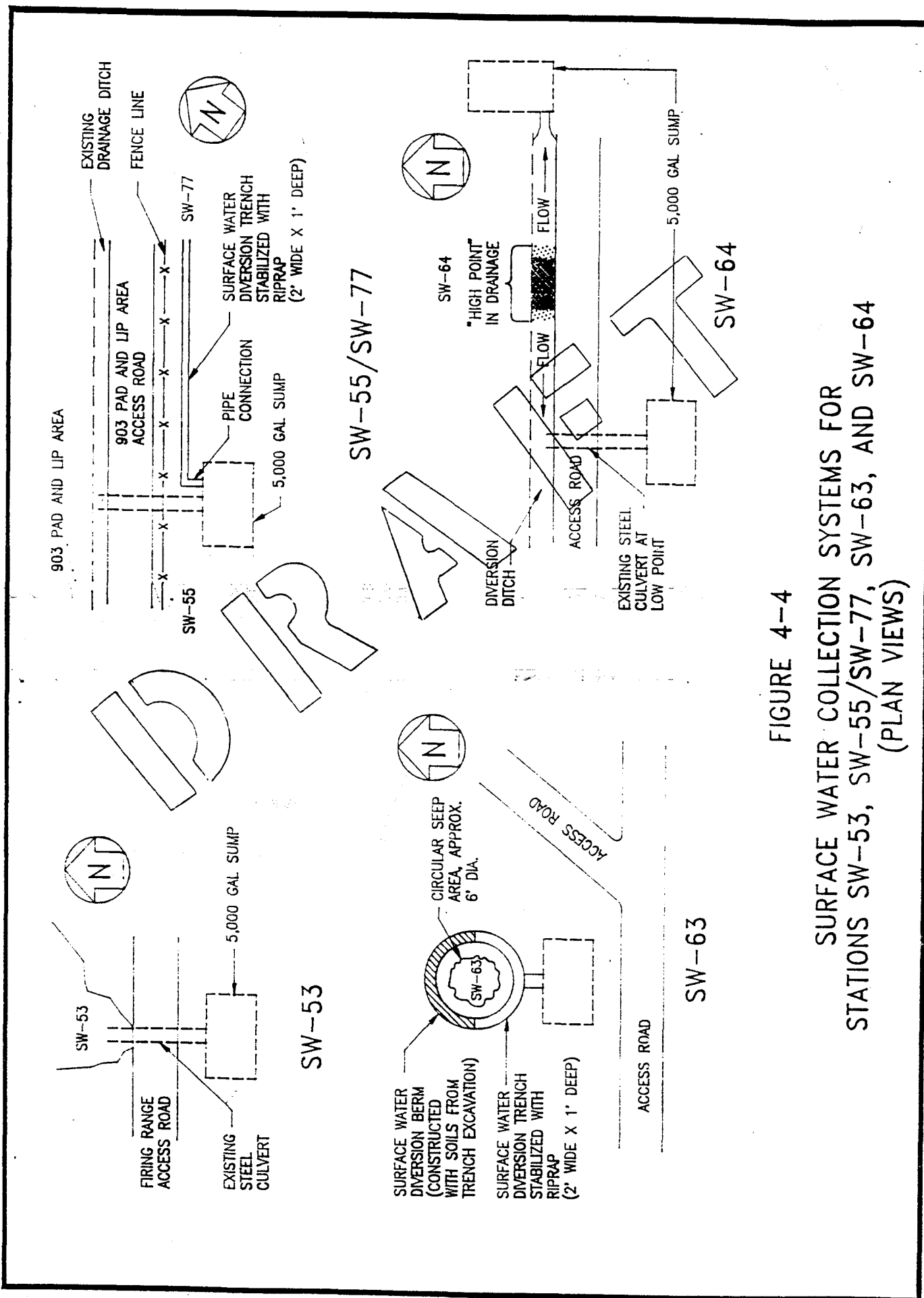


FIGURE 4-4
 SURFACE WATER COLLECTION SYSTEMS FOR
 STATIONS SW-53, SW-55/SW-77, SW-63, AND SW-64
 (PLAN VIEWS)

located at the low point of the trench. The sump will be constructed of concrete and will have a capacity of 5000 gallons. The trench will be stabilized with riprap and soils generated from the excavation will be used to construct a half-circle shaped berm upslope of the seep to divert surface water runoff from the collection system.

Surface water seep SW-64 flows into a ditch adjacent to the north side of the site access road shown on Figure 4-1. The seep extends approximately 160 feet within the ditch and a high point in the center of the ditch results in water collection on either side of the ditch. A steel culvert buried beneath the access road at the western side of the seep drains the seep water accumulating on this side of the ditch downgradient towards the South Interceptor Ditch. A 5000-gallon concrete sump located at the outlet of the existing culvert is used to collect and store this flow. A second 5000-gallon concrete sump is used to collect the seep water flowing east from the high point in the ditch as illustrated in Figure 4-4. Excavated soils will be used to construct a runoff diversion berm upslope of the existing ditch.

4.3.1.2 Effectiveness

Collection of Operable Unit No. 2 surface water by diversion at the sources represents an effective collection alternative that satisfies the objectives of the IM/IRA discussed in Section 3.1. Minimization of potential threats to human health and the environment are achieved by containing contaminated surface waters at the source. This is achieved by reducing downstream contaminant migration via surface water and ground water, and volatilization of organic compounds to the atmosphere.

4.3.1.3 Implementability

The equipment and materials required to construct the diversion and collection systems for this alternative are standard and readily available. Access roads exist to all proposed collection system site locations. Power currently exists near the proposed locations for CS-61 and CS-103, the two systems incorporating pumped transfer of the collected water to the treatment facility. The collection systems are simple in design and should, therefore, offer reliable, and relatively maintenance free operation. Manholes, sumps, and backwater ponds will require periodic cleaning to remove accumulated solids. Dust suppression and

worker and public health protection must be addressed during construction because of plutonium contaminated surface soils in the vicinity of the 903 Pad Lip Site.

4.3.1.4 Costs

Capital and operating costs for the surface water diversion alternative are shown in Table 4-4. The collection system can be constructed for \$ 319,000 with annual operation and maintenance costs of \$ 130,700. At an interest rate of 10 percent and an operating life of 30 years, the present worth of this system is approximately \$1,551,100.

4.3.2 Surface Water Collection at Ponds B-5 and C-2

4.3.2.1 Description

As shown in Figure 4-1, seepage at the 903 Pad Lip Site and other seeps in this general vicinity flows into the South Interceptor Ditch and eventually to Pond C-2; and contaminated water in the upper reach of South Walnut Creek ultimately flows to Pond B-5 (via Pond B-4). Ponds C-2 and B-5 are proposed for collection of contaminated surface water for this alternative. The ponds would be operated at dead storage, or near empty, levels to maximize capacity during storm runoff events. A precipitation/runoff and storage/pump model should be used to estimate the required pumping capacity to prevent by-pass of untreated water during a design storm event. This level of effort has not been applied to the problem because of the overwhelming deficiencies of this approach (see Effectiveness) to contaminated surface water collection. However, it is noted that the current pump and treat operation at Pond B-5 has necessitated operation at 500 gpm to avoid downstream release of untreated water.

4.3.2.2 Effectiveness

This alternative is more effective than the source collection alternative in capturing contaminants because of the much larger capacity to contain high flows. However, without source collection, contaminants

**TABLE 4-4
ESTIMATED COSTS FOR SURFACE WATER DIVERSION
AND COLLECTION SYSTEMS**

| A. <u>EQUIPMENT AND MATERIALS</u> | | <u>CAPITAL COST</u> <u>(DOLLARS)</u> | <u>ANNUAL COST</u> <u>(DOLLARS)</u> |
|--|---|---|--|
| <u>Quantity</u> | <u>Item</u> | | |
| 6 | 5000 gallon concrete sump | \$45,000 | |
| 6 | Liquid transfer pump | 2,000 | |
| 4000 ft | Insulated heat traced piping | 14,000 | |
| 200 cu yd | Concrete | 25,000 | |
| 2 | Pump station intake structures | 2,000 | |
| 1 | 5000-gallon tanker truck | 70,000 | |
| B. <u>INSTALLATION</u> | | | |
| <u>Quantity</u> | <u>Item</u> | | |
| 2 | ¹ Trench construction | \$ 3,000 | |
| 2 | ² Diversion weir or pump station | 23,400 | |
| 6 | ³ Sump installation | 26,300 | |
| - | Miscellaneous installation materials | 2,000 | |
| C. <u>OPERATION AND MAINTENANCE</u> | | <u>(DOLLARS)</u> | <u>(DOLLARS)</u> |
| <u>Quantity</u> | <u>Item</u> | | |
| 6 | ⁴ Sump cleaning | | \$ 17,300 |
| 2 | ⁵ Intake structure cleaning | | 2,900 |

- ¹ Trench construction costs are based on 24 manhours of labor at \$60/hr plus a \$500 backhoe rental charge
- ² Diversion weir and pump station installation costs are based on 325 manhours of labor at \$60/hr plus a \$4,000 backhoe rental charge
- ³ Sump installation costs are based on 390 manhours of labor at \$60/hr plus a \$3,000 backhoe rental charge
- ⁴ Annual sump cleaning costs are based on 290 manhours of labor at \$60/hr
- ⁵ Intake structure cleaning

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**TABLE 4-4 (cont.)
ESTIMATED COSTS FOR SURFACE WATER DIVERSION
AND COLLECTION SYSTEMS**

| C. | <u>OPERATION AND MAINTENANCE</u> | <u>CAPITAL COST (DOLLARS)</u> | <u>ANNUAL COST (DOLLARS)</u> |
|----|---|-----------------------------------|----------------------------------|
| | ⁶ Pipeline Maintenance | | \$ 5,800 |
| | ⁷ Power | | 22,900 |
| | ⁸ Tanker Truck Operation | | 60,000 |
| | SUBTOTAL | \$212,700 | \$108,900 |
| D. | <u>ENGINEERING AND CONTINGENCY</u> | | |
| | Design at 25% of Capital Cost | \$ 53,200 | |
| | Construction Management at 5% of Capital Cost | 10,600 | |
| | Contingency at 20% | 42,500 | 21,800 |
| | TOTAL COST | \$319,000 | \$130,700 |

PRESENT WORTH

| | | |
|----------------------------|---|---|
| Present Worth Factor (PWF) | = | 9.427 (30 years, 10%, for annual costs) |
| \$130,700/year x 9.427 | = | \$1,232,100 |
| 1990 Capital Cost | = | <u>\$ 319,000</u> |
| | | \$1,551,100 |

⁶ Annual pipeline maintenance costs are based on 96 manhours of labor at \$60/hr

⁷ Annual electrical power costs are based on four 50 hp liquid transfer pumps operating 25% of time of each day at \$0.07/Kwh

⁸ Tanker truck operation costs for collection systems CS-53, CS-55, CS-63, and CS-64 are based on 120 mandays of labor at \$60/hr plus \$25/day for gasoline and maintenance

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continue to move downgradient from the sources via surface water and ground water, and contaminants will be transferred to the atmosphere by volatilization. This increases the extent of contamination, and the "problem" is partially solved by unmitigated transfer of contaminants simply from one medium to another, i.e., volatilization.

4.3.2.3 Implementability

With the exception of a pumping system, the collection/transfer system already exists. Thus, the alternative is easily implemented. However, the high flow requiring treatment is a significant negative "downstream" impact of this alternative. Furthermore, in choosing the source collection alternative, this alternative is an effective "backup" to preventing off-site releases of contaminated surface water. Because Ponds B-5 and C-2 are NPDES discharge points, DOE must necessarily implement this "backup" alternative to remain in compliance with the Plant's NPDES permit.

4.3.2.4 Costs

Costs have not been provided for a pump station and transfer line because of the low probability of selecting this contaminated surface water collection alternative as the primary mechanism for containing contaminated surface water. However, it is noted that a pump/transfer system will cost significantly less to build and operate than the source diversion collection alternative.

4.4 EVALUATION OF SURFACE WATER TREATMENT TECHNOLOGIES

4.4.1 Suspended Solids Removal

In this section, advanced membrane filtration (MEMTEK), and contact filtration using a polymer and continuous backwash filter are evaluated to determine the cost-effective technology for suspended solids removal. These two processes differ from conventional water clarification (chemical addition followed by gravity separation and filtration) by virtue of the lower sludge volumes generated. As discussed in the following subsections, each of these technologies will also remove radionuclides and metals to a certain degree.

4.4.1.1 Advanced Membrane Filtration

Description

Advanced membrane filtration is a membrane separation technology developed by the MEMTEK Corporation for removal of suspended solids, dissolved metals, and radionuclides. (Chemical addition and removal mechanisms for dissolved metals and radionuclides are discussed in Section 4.4.2.1). As shown in Figure 4-5, the process consists of chemical addition to increase the solids concentration, filtration through a 0.1u filter, solids recirculation, solids separation and dewatering, and final neutralization. As discussed in more detail in Section 4.2.2.1, chemical addition is a pretreatment step for initiating precipitation, co-precipitation, and adsorption of metals, i.e., conversion to the solid phase. However, the solids will aid in the removal of influent suspended solids by coagulation of fine particles and/or enmeshment in the hydrous metal oxide flocs. The pretreated feed combines with the recycle stream (2 - 5 % solids) from the filtration unit, and is subsequently filtered. The filter is in a shell and tube configuration with the membrane on the inside of the tubes. The permeate passes through the tubes perpendicular to the main flow at a low operating pressure [20-40 pounds per square inch (psi)]. The flux through the filter is high relative to other membrane technologies, eg. reverse osmosis and ultrafiltration, because of the large pore diameter of the filter. Flux rates of 200 - 400 gallons per square foot per day (gal/ft²/d) are typical for the membrane. A fraction of the recycle slurry is bled off for solids removal through gravity separation and mechanical dewatering. The permeate (flow passing through the filter) is neutralized before discharge.

For the surface water IM/IRA, a model M-4400 unit will be required. The unit is modular and skid mounted, and has an output capacity of 40 - 88 gpm and requires 40 kilowatts (kw) of power. Components include the following:

- 2 1200-gallon reaction tanks;
- 1 3000-gallon concentration tank;
- 1 700 gpm recirculation pump

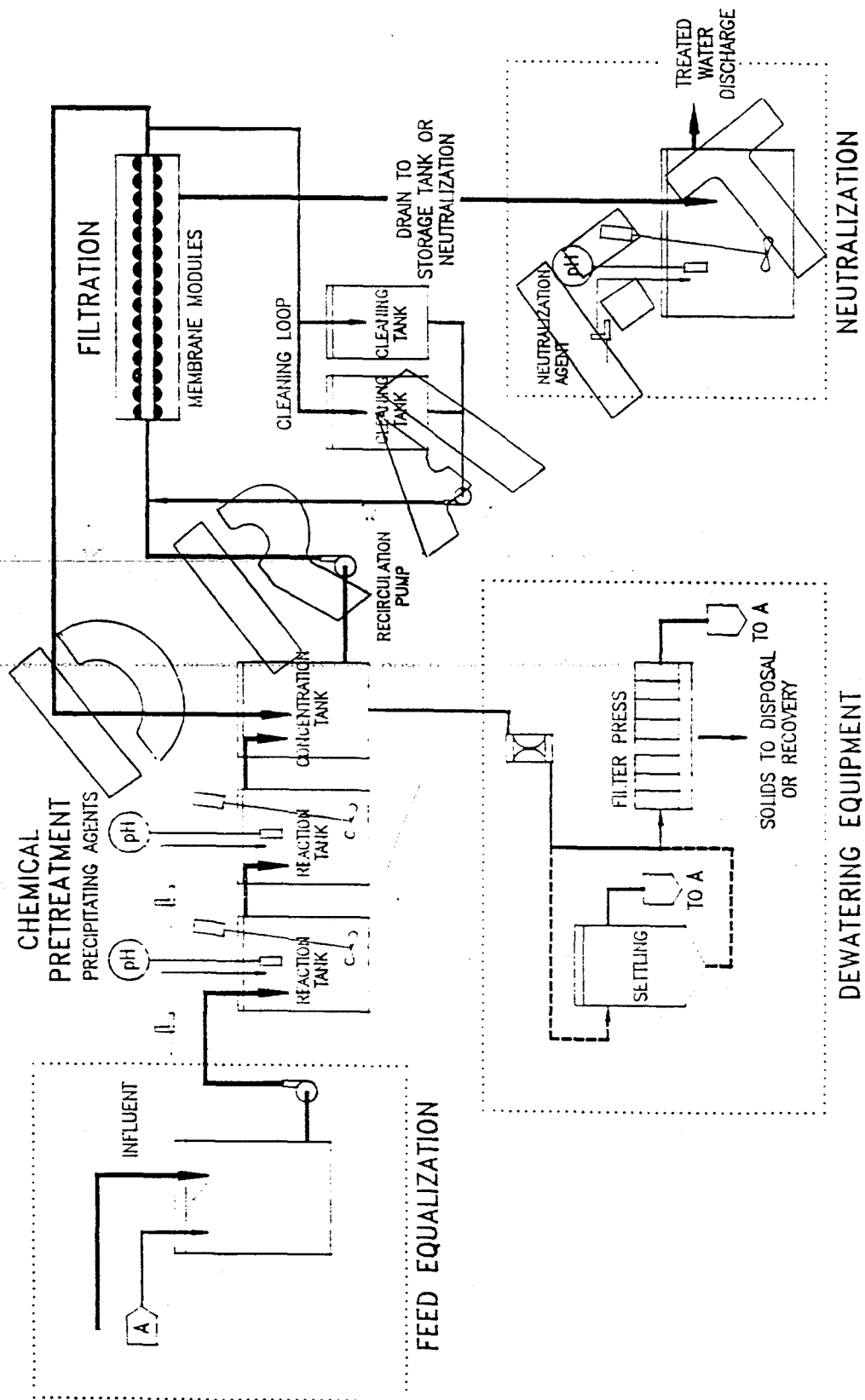


FIGURE 4-5
MEMTEK ADVANCED MEMBRANE FILTRATION SYSTEM

- 1 cleaning system; and
- 28 tubular membrane filtration modules.

Auxiliary tanks and process equipment includes:

- 2 250-gallon chemical feed tanks;
- 1 1500-gallon solids sedimentation tank; and
- 1 10-cubic feet per day plate and frame filter press for sludge dewatering.

Effectiveness

Advanced membrane filtration is highly effective at removal of suspended solids. There are numerous applications of this technology in use throughout the United States. Effluent suspended solids concentrations are less than 1 mg/l (Tiepel and Shorr, 1985). Because the radionuclides are largely associated with the suspended solid fraction (see Section 4.2.2.1), simple suspended solids removal is anticipated to remove greater than 90% of these constituents. In this manner, the threat to the public health and environment is significantly reduced in terms of potential future radionuclide exposure, and it is likely that the chemical specific ARARs will be achieved (practically ensured with the proper chemical feed).

Dewatered solids generated in the process will be handled as a low level mixed waste. It will require solidification (to be performed at existing facilities at the Rocky Flats Plant to meet radioactive waste transportation and disposal requirements (49 CFR 173 and 10 CFR 71). The solidified waste will be disposed of at the Nevada Test Site once it is sampled and analyzed to determine compliance with recently promulgated land ban restrictions (Federal Register, Vol. 55, No. 61, March 29, 1990). The low dissolved metal content of the surface water and the low percent removal of volatile organics by the process indicates that the land ban regulations will be easily met.

Implementability

MEMTEK has been providing advanced membrane filtration units to industry, municipalities, and contractors involved in ground water and surface water remediation since 1979. There are hundreds of units in operation today demonstrating that advanced membrane filtration is a reliable process. The high solids content of the recycle flow produces scour action on the membrane minimizing fouling and thus the cleaning frequency (1 hour every 40-80 hours of operation). The membrane, an inert fluorocarbon material, can be cleaned with strong oxidants (hypochlorite) to remove bacterial films, or strong acids or bases to remove deposited metal hydroxides. The membrane will not degrade in the presence of the dilute concentrations of the solvents in the surface water.

The skid mounted MEMTEK unit can be delivered to the site within 90 days of purchase. The unit will include all tanks, piping, pumps, control panel, and chemicals. The unit can be operational within 5 days of delivery to the site provided that power is readily available.

Costs

Capital and operational costs for the MEMTEK system are shown in Table 4-5. Note that process stream monitoring and analysis costs are not included in the estimate for the MEMTEK unit or other treatment units examined in this section since these costs are common to all treatment units. The MEMTEK microfiltration system can be installed for \$ 486,500, with annual operation and maintenance costs of \$ 213,000 per year. Assuming a 10% interest rate and a 30-year operating life, the present worth of the system is \$ 2,494,500.

4.4.1.2 Contact Filtration

Description

The continuous backwash, DynaSand, filter was introduced to the United States by the Parkson Corporation in 1979. As shown in Figure 4-6, polymer is injected into the surface water followed by rapid mixing in an in-line static mixer. Water rises through the bed where flocculation, coagulation, and floc removal

TABLE 4-5

ESTIMATED COSTS FOR ADVANCED MEMBRANE FILTRATION PROCESS

| <u>Item</u> | <u>Capital Cost (Dollars)</u> | <u>Annual Cost (Dollars)</u> |
|------------------------|-----------------------------------|----------------------------------|
| A. MEMTEK Model M-4428 | \$216,100 | |

Includes:

Quantity Item

| | |
|---|---|
| 2 | 1200-gallon Reaction Tank with Mixer pH Controller, and Metering Pump |
| 1 | 3000-gallon Concentration Tank |
| 1 | 700 gpm Recirculation Pump Membrane Filtration Modules Membrane Cleaning System ¹ Electrical ¹ Piping |

B. AUXILIARY EQUIPMENT

QuantityItem

| | | |
|---|---|-----------|
| 1 | 10,000-gallon Equalization Tank | \$ 14,500 |
| 1 | Model P8-250 Lime Slurry System Includes 250-gallon Tank, Mixer, Recirculation Pump, Level Control | 11,400 |
| 2 | Model PC-250 Powdered Chemical System Includes 250-gallon Tank, Mixer, Metering Pump | 6,000 |
| 1 | Model NS-1500 Neutralization System Includes 1500-gallon Tank, Mixer, Metering Pump pH monitor/controller | 19,500 |
| 1 | 10-Cu. Ft. Filter Press Includes Feed Pump, Dumpster, Air Blowdown System | 36,000 |
| 2 | Trailer | 44,000 |

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TABLE 4-5 (cont.)

ESTIMATED COSTS FOR ADVANCED MEMBRANE FILTRATION PROCESS

| <u>Item</u> | <u>Capital Cost (Dollars)</u> | <u>Annual Cost (Dollars)</u> |
|--|-----------------------------------|----------------------------------|
| C. OPERATING COSTS | | |
| ² Operation and Maintenance | | \$131,000 |
| ³ Monitoring and Analysis | | |
| ⁴ Power | | 24,500 |
| ⁵ Sludge Waste Disposal | | <u>22,000</u> |
| SUBTOTAL | <u>\$347,500</u> | \$177,500 |
| D. ENGINEERING AND CONTINGENCY | | |
| Design at 15% of Total Capital Cost | \$ 52,100 | |
| Construction Management at 5% of Total Capital Cost | 17,400 | |
| Contingency at 20% | <u>69,500</u> | <u>35,500</u> |
| TOTAL COST | \$486,500 | \$213,000 |

Present Worth:

| | |
|------------------------------|--|
| Present Worth Factor (PWF) = | 9.427 (30 years, 10% i for annual costs) |
| \$213,000/year x 9.427 = | \$2,008,000 |
| 1990 Capital Cost = | <u>486,500</u> |
| | \$2,494,500 |

- 1 Electrical and mechanical service for connections less than or equal to 10 feet are included in the cost of the basic system.
- 2 Operation and maintenance for surface water treatment is based on one operator per shift, for three shifts per day at 2 hours per shift, seven days per week at \$60/hour.
- 3 Monitoring and analytical costs are not included because they are the same for all treatment technologies considered for the IM/IRA.
- 4 Power cost estimate is based on a process power requirement of 40 KW, operated continuously at \$0.07/Kw-Hr.
- 5 To be conservative in cost estimating, it is assumed that filter press sludge is mixed waste requiring disposal at the Nevada Test Site at a unit cost of \$450/cu. yd. Annual production of filter cake is based on an average year-round influent flow of 20 gpm containing approximately 350 ppm of suspended solids. The filter cake produced is assumed to be 30% solids by weight.

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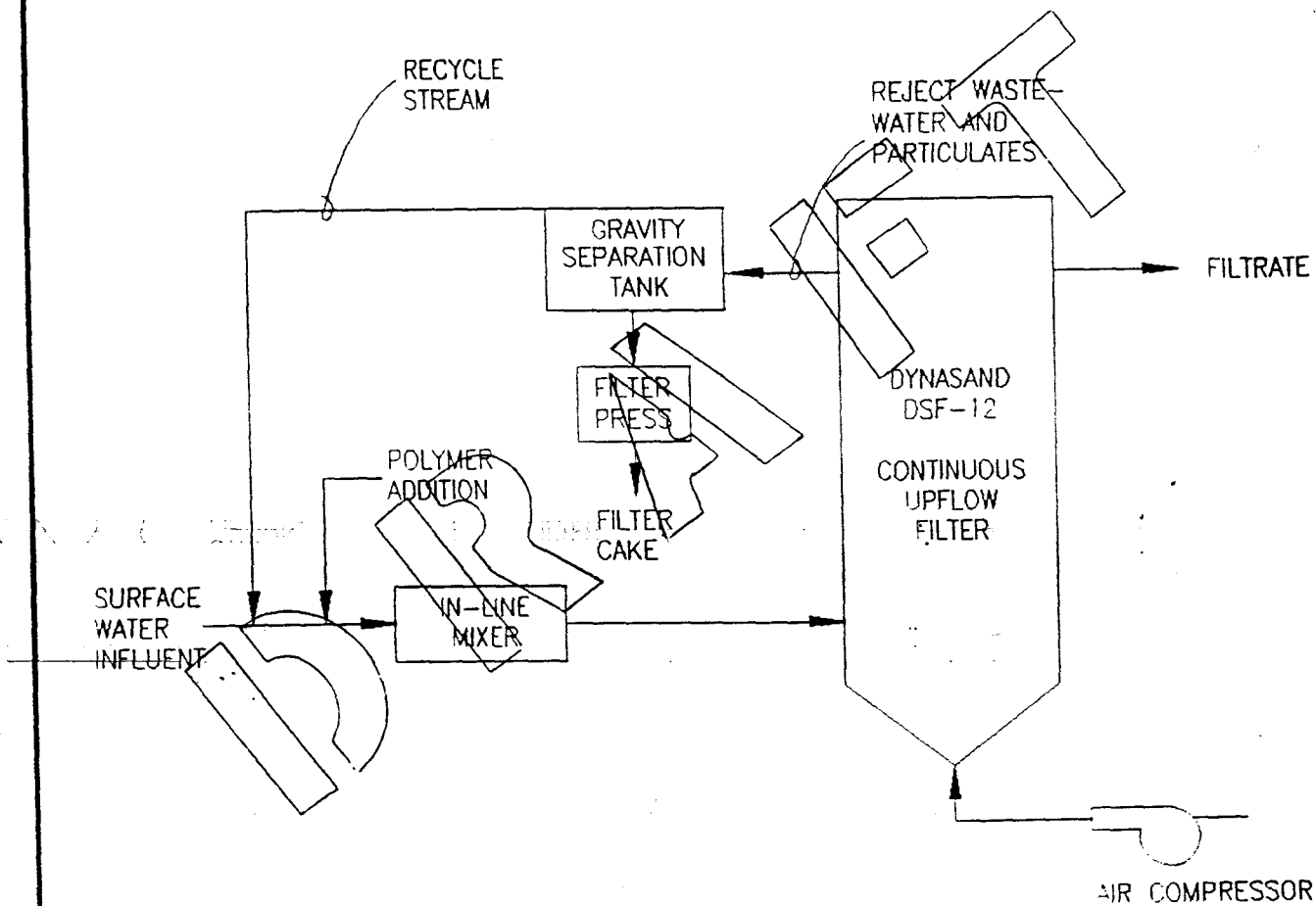


FIGURE 4-6

CONTINUOUS CONTACT FILTRATION TREATMENT UNIT

occur. Clean water overflows a weir at the top of the sand bed. As the water rises, sand moves downward through the bed countercurrent to this flow of water. This downward motion is induced by an air lift system in the center of the bed (centralized pipe with air injection at the base) that draws the sand upward. Turbulent flow is created in this air lift scouring the dirt from the sand. The dirt/sand slurry spills over at the top of the air lift into a compartment with a perforated bottom and overflow weir. The rapidly settling sand separates from the dirt in this compartment, and the clean sand is returned to the top of the sand bed. The dirty water exiting the filter would be directed to a sedimentation tank, and the overflow from this tank sent back to the filter. The solids from this tank will require dewatering, solidification, and ultimate disposal at the Nevada Test Site as a low level waste.

DynaSand filters are designed based on a hydraulic loading of 4-5 gpm/ft². For the surface water IM/IRA, a model DSF-12 packaged fiberglass unit with filtration area of 12 ft², a diameter of 4 feet, a height of 12 feet with a sand bed depth of 40 inches (3.3 tons of sand), and requiring 0.5 - 1.5 standard cubic feet per minute (SCFM) of air at 15-25 pounds per square inch (psi) would be applicable. A 10,000-gallon settling tank as well as a sludge conditioning and dewatering system will also be required.

Effectiveness

The DynaSand filter is as effective at removal of suspended solids as conventional flocculation/coagulation and rapid sand filtration. The effluent from this system will be suitable for subsequent downstream treatment for radionuclide and organics removal. Plutonium, and to a lesser extent uranium, will be largely removed in this unit because plutonium exists predominantly as a colloid in natural waters.

Implementability

DynaSand filters are particularly suitable for small water treatment plants where operating personnel are limited. It operates continually without the need to be shut down for backwashing because it is self cleaning, and has no moving parts. Relative to conventional suspended solids removal, it is cost effective in terms of both capital and operating expenses.

Costs

Capital and operational costs for the DynaSand filter and appurtenances are shown in Table 4-6. The system can be installed for \$ 167,100, with annual operation and maintenance costs of \$ 82,100 per year. Assuming a 10% interest rate and 30-year operating life, the present worth of the system is \$ 941,100.

4.4.2 Radionuclide Removal

4.4.2.1 Advanced Membrane Filtration

Description

The advanced membrane filtration system was previously discussed in Section 4.4.1.1. In this section the chemistry and removal mechanisms for uranium and plutonium, as applied to advanced membrane filtration, are discussed.

There are five oxidation states of plutonium in aqueous solutions: Pu(III), Pu(IV), Pu(V), Pu(VI), and Pu(VII). However, under the oxidizing and near neutral conditions expected in the surface water, the Pu(IV) oxidation state is the most stable (Cleveland, 1979). Pu(IV) is practically insoluble under these conditions because it readily hydrolyzes to form $\text{Pu}(\text{OH})_4(\text{s})$, and upon loss of water, to produce the thermodynamically stable $\text{PuO}_2(\text{s})$. This solid phase is a colloidal polymer of neutral or positive charge. Increasing pH tends to reduce the charge density of the polymer, and at pH's above 9 it is presumed that the colloid becomes negatively charged. This reduction in charge density and eventual conversion to an anionic form at pH's above 9 decrease its adsorption affinity for soils and thus its mobility in the soil/water environment. In solution, Pu(V) and Pu(VI) coexist as ions with the Pu(IV) polymer. At a pH of 8, the dominant ionic form of plutonium is $\text{PuO}_2\text{CO}_3\text{OH}^-$ occurring at only a concentration of approximately 10^{-12}M (1.5×10^{-5} pCi/l). However, the solubility of plutonium can be increased through complexation with humic acids.

TABLE 4-6
ESTIMATED COSTS FOR CONTACT FILTRATION
TREATMENT UNIT

| <u>Item</u> | | <u>Capital Cost</u> <u>(Dollars)</u> | <u>Annual Cost</u> <u>(Dollars)</u> |
|---------------------------------------|---|---|--|
| A. EQUIPMENT | | | |
| <u>Quantity</u> | <u>Item</u> | | |
| 1 | DynaSand Model DSF-12 Continuous Flow Sand Filter | \$ 24,000 | |
| 1 | 10,000-Gallon Equalization Tank | 12,500 | |
| 1 | Air Compressor and Dryer | 3,800 | |
| 1 | Pump and Associated Piping | 500 | |
| 1 | 10,000-Gallon Sedimentation Tank | 12,500 | |
| 1 | 10-cubic feet per day filter press | 44,000 | |
| 1 | Trailer | 22,000 | |
| B. OPERATION AND MAINTENANCE | | | |
| | ¹ Operator and Maintenance | | \$ 43,800 |
| | ² Monitoring and Analysis | | |
| | ³ Power | | 2,600 |
| | ⁴ Sludge Waste Disposal | | <u>22,000</u> |
| | SUBTOTAL | \$119,300 | \$ 68,400 |
| C. ENGINEERING AND CONTINGENCY | | | |
| | Design at 15% of Total Capital Cost | \$ 17,900 | |
| | Construction Management at 5% of Total Capital Cost | 6,000 | |
| | Contingency at 20% | <u>23,900</u> | <u>13,700</u> |
| | TOTAL COST | \$167,100 | \$ 82,100 |

PRESENT WORTH

| | |
|------------------------------|---|
| Present Worth Factor (PWF) = | 9.427 (30 years, 10%i for annual costs) |
| \$82,100/year x 9.427 = | \$774,000 |
| 1990 Capital Cost = | <u>167,100</u> |
| | <u>\$941,100</u> |

- ¹ Operating and maintenance costs are based on 2 manhours of labor per day at \$60/hour.
- ² Monitoring and analytical costs are not included because they are the same for all treatment technologies considered for this IM/IRA.
- ³ Electric power costs are based on a 3 hp pump and a 2 kw air compressor at \$0.07 per kwh.
- ⁴ To be conservative in cost estimating, it is assumed that filter press sludge is mixed waste requiring disposal at the Nevada Test Site at a unit cost of \$450/cu. yd. Annual production of filter cake is based on an average year-round influent flow of 20 gpm containing approximately 350 ppm of suspended solids. The filter cake produced is assumed to be 30% solids by weight.

There are four oxidation states of uranium: U(III), U(IV), U(V), and U(VI) (Sorg, 1987). U(III) and U(V) are unstable, and U(VI) is the thermodynamically predicted oxidation state of uranium in oxic water. U(VI) predominantly exists as the uranyl ion (UO_2^{2+}). The uranyl ion readily complexes with the common anions chloride, sulfate, nitrate, and carbonate. In water with carbonate alkalinity and a pH range of 7-10, the dominant soluble species of uranyl is $\text{UO}_2(\text{CO}_3)_2^{2-}$ and $\text{UO}_2(\text{CO}_3)_3^{4-}$. At pH's exceeding 9.5, the uranium hydroxide complex $(\text{UO}_2)_3(\text{OH})_5^+$ becomes predominant. Unlike plutonium, uranium is significantly more soluble in water.

Both plutonium and uranium are removed from solution in the advanced membrane filtration process by adsorption on a ferric hydroxide floc. Because the predominant form of plutonium in the surface water is particulate, the advanced membrane filtration process will remove this radionuclide from the influent through adsorption to and enmeshment in the ferric hydroxide. The most effective removal of uranium by conventional coagulation using iron salts is at a pH greater than 9.5. This is presumed to be due to the predominance of the positively charged uranium hydroxide ion in the presence of the negatively charged ferric hydroxide (Sorg, 1987).

Ferric sulfate ($\text{Fe}_2(\text{SO}_4)_3$) is the iron salt of choice for introducing ferric iron to the influent stream. Because of the residual acid in the salt, the pH drops to 2-3 which facilitates dissolution of the iron salt. The ferric sulfate is automatically fed in dry form to the influent in reaction tank No. 1 (see Figure 4-5). The ferric ion will rapidly hydrolyze at high pH's (9-11) to form ferric hydroxide $(\text{Fe}(\text{OH})_3(\text{s}))$. Lime $[(\text{Ca}(\text{OH})_2)]$ is automatically added in reaction tank No. 2, and is used to raise the pH, which also improves the compressibility of the ferric hydroxide sludge. pH adjustment will be required prior to discharge of the permeate to maintain the effluent in a pH range of 6 to 9. This will be accomplished with a pH controller.

Effectiveness

Although limited, there is data demonstrating the removal of plutonium from water using advanced membrane filtration. The only data available is from a study performed at the Rocky Flats Plant using a small

scale advanced membrane filtration unit (< 1 gpm) treating plutonium and uranium contaminated laundry water.

Results are shown below:

| <u>Parameter</u> | <u>Concentration (pCi/l)</u> | |
|------------------|------------------------------|-----------------|
| | <u>Influent</u> | <u>Effluent</u> |
| Gross alpha | 2,480 | 5.3 |
| Gross beta | 3,933 | 8.9 |
| Total uranium | 1,238 | 2.25 |
| Plutonium | 63.4 | 0.25 |

The plutonium removal efficiency for the above test is greater than 99%. Other data from previous test runs indicated effluent plutonium concentrations less than the detection limit (0.1 pCi/l). Considering the complexing agents present in laundry water, it is promising that the advanced membrane filtration process can meet the chemical specific ARAR for plutonium of 0.05 pCi/l. Using the percent plutonium removal for the above reported test and the expected influent concentration of plutonium to the treatment facility, the ARAR is computed to be achieved.

Because of its ubiquity in water supplies, there is considerable more information on the removal of uranium during water treatment. Uranium removal efficiencies have been reported for conventional coagulation/filtration water treatment, and data exist for advanced membrane filtration used at the Rocky Flats Plant and at Uranium Mill Tailings Remedial Action (UMTRA) sites. With regard to conventional water treatment, using a dose of 10 mg/l of ferric sulfate as a coagulant with a pH of 10, 80% removal of uranium has been reported (Sorg, 1987). Use of ferrous sulfate at doses between 20 - 25 mg/l and at the same pH resulted in removals as high as 92 - 93%. For advanced membrane filtration, the above reported test at the Rocky Flats Plant indicates achieving greater than 99% removal and meeting the chemical specific ARAR for uranium (10 pCi/l). At the Canonsburg Uranium Mill Tailing Remedial Action (UMTRA) site, water containing 4,400 pCi/l of total uranium was treated to achieve a total uranium concentration of less than 1 pCi/l. Although specific data is unavailable, the advanced membrane filtration unit operating at the Durango UMTRA site is achieving effluent uranium concentrations below the Colorado in-stream standards for that area.

It would appear that advanced membrane filtration should be effective for removal of plutonium and uranium from the surface water at Operable Unit No. 2. Chemical specific ARARs should be achieved for both plutonium and uranium, although there is less data and correspondingly less certainty on the performance of the system for plutonium removal. Chemical specific ARARs for gross alpha and gross beta should also be achieved. The gross alpha is largely from uranium and particulate forms of plutonium and americium, and most of the gross beta arises from uranium 238 daughters, eg., thorium 232 and protactinium 234. The thorium and protactinium predominantly exist in the particulate fraction and should be removed by advanced membrane filtration via adsorption on iron hydroxide. Although naturally occurring cesium 137, potassium 40, lead 210, and strontium 90, which are more soluble, also contribute to gross beta activity, the success of the current filtration operation to lower the gross beta concentration at Pond B-5 would indicate that they are not significant contributors to the gross beta activity in South Walnut Creek. Removal of the radionuclides should effectively reduce the potential threat to the public health and the environment. As described in Section 4.4.1.1, sludges will be solidified and disposed at the Nevada Test Site.

Implementability

See Section 4.4.1.1 for a discussion of the implementability of the advanced membrane filtration process.

Costs

See Section 4.4.1.1 (Table 4-5) for a presentation of capital and operating and maintenance costs of the advanced membrane filtration process.

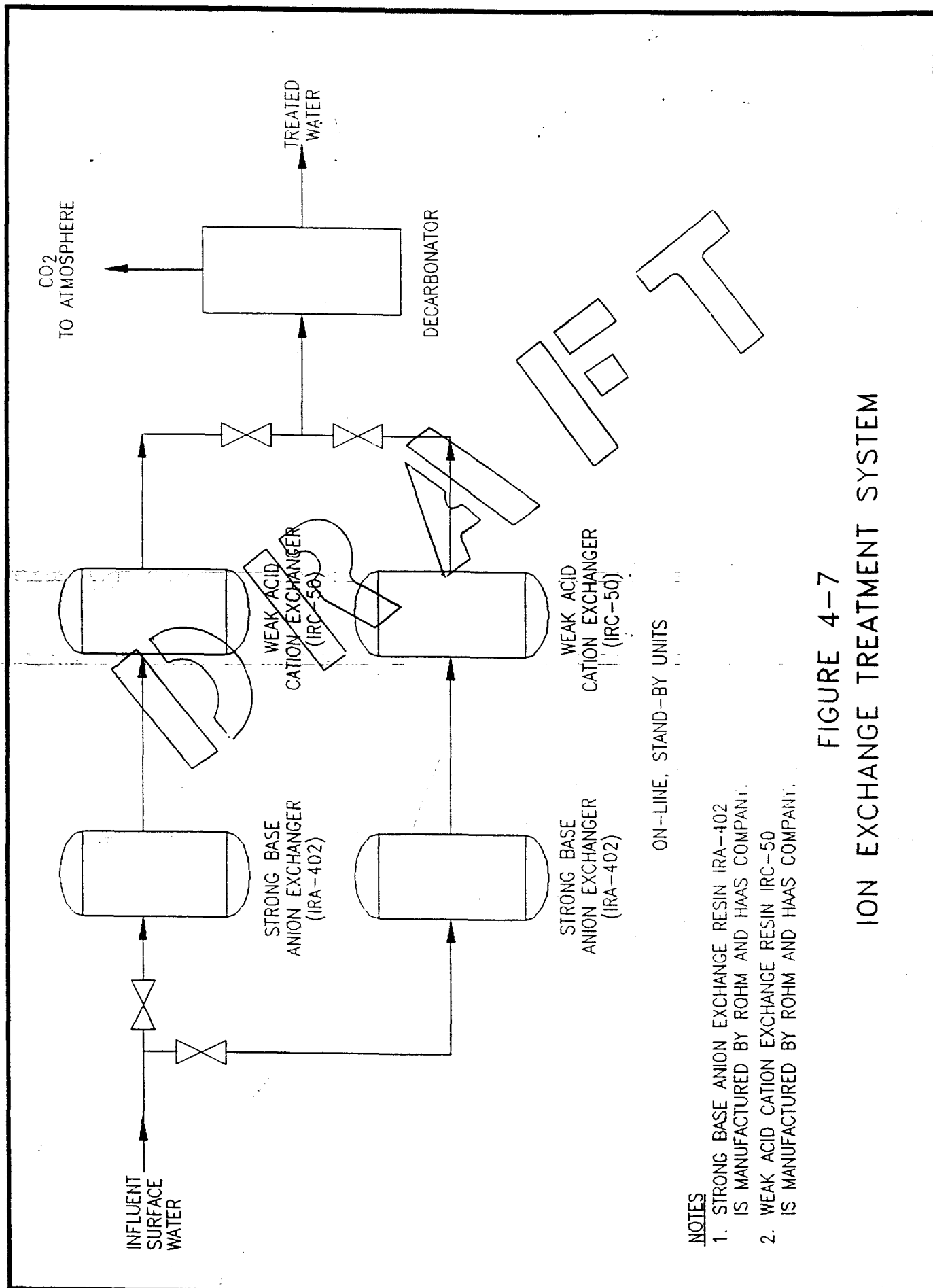
4.4.2.2 Ion Exchange

Description

The ion exchange treatment system for the removal of radionuclides consists of a strong base anion exchanger followed by a weak acid cation exchanger (Figure 4-7). These exchangers are designed for the removal of uranium and plutonium, respectively. Both ion exchangers have been designed conservatively using a hydraulic loading less than 5 gpm/ft² and a bed capacity less than 2 gpm/ft³. This translates to a 4 foot diameter column with a resin bed depth of 3 feet. The column will include 100% freeboard. This freeboard is necessary for resin expansion during regeneration or for backwashing if required.

The strong base anion exchanger will contain 37.5 ft³ of Rohm and Haas IRA-402 resin in the chloride form. Regeneration will not be required because of the high affinity and capacity of the resin for uranium. The expected life of the unit is greater than 30 years at the expected influent uranium concentration. Although other anions will be adsorbed to the resin, the preferential adsorption of uranium over other anions in solution will, over time, displace these anions. The spent resin will ultimately require solidification and disposal at the Nevada Test Site.

The cation exchanger will contain 37.5 ft³ of Rohm and Haas IRC-50 weak acid cation exchange resin in the sodium form. This resin has a high affinity for high molecular weight metals, eg., mercury, copper, lead, and zinc. Published information on the removal of plutonium from natural waters by ion exchange has not been found. A cation exchange resin with a high affinity for heavy metals was chosen for conceptual design purposes because the plutonium will predominantly exist as a colloid carrying a positive charge. The performance of ion exchange for the removal of plutonium is unknown; however, it is noted that most of the plutonium should be removed during upstream suspended solids removal. There is insufficient information to determine the frequency the resin will require regeneration. It is assumed that, like the anion exchanger, the cation exchanger will not require regeneration over the life of the interim action.



NOTES

1. STRONG BASE ANION EXCHANGE RESIN IRA-402 IS MANUFACTURED BY ROHM AND HAAS COMPANY.
2. WEAK ACID CATION EXCHANGE RESIN IRC-50 IS MANUFACTURED BY ROHM AND HAAS COMPANY.

FIGURE 4-7
ION EXCHANGE TREATMENT SYSTEM

Effectiveness

Ion exchange has been proven to remove uranium from water to meet the chemical specific ARARs, whereas plutonium removal using this technology is unproven. Ion exchange has been used to remove uranium from mine water for many years, and has been studied extensively by EPA for the removal of uranium from drinking water (Sorg, 1987). Ion exchange is commonly used for the removal of plutonium from strong acid solutions but no information exists on the use of ion exchange for the removal of plutonium present in natural waters. Bench and pilot scale treatability studies are highly recommended before this technology is used for the surface water IM/IRA. If effective, ion exchange would remove the radionuclides and thus protect downstream units from accumulating radioactivity, i.e., activated carbon. As previously mentioned, spent ion exchange resin will require solidification and disposal at the Nevada Test Site as a low level waste.

Implementability

Ion exchange resins are commercially available off-the-shelf systems that can be purchased and installed readily. If the weak acid cation exchanger requires regeneration, an acid regeneration system would be required, and the waste water from regeneration would require storage, and treatment at the Building 374 Process Waste Treatment System (chemical precipitation/flash evaporation). If regeneration of the cation exchange resin is not required, operation and maintenance requirements for the system will be low. Effluent would be routinely monitored for break through of the radionuclides shown in Table 3-3.

Costs

Capital and operational cost for the ion exchange system is shown in Table 4-7. The system can be installed for \$289,900, with annual operation and maintenance costs of \$ 45,400 per year. The operation and maintenance cost assumes that regeneration of the weak acid cation exchange resin will not be required. At an interest rate of 10% and an operating life of 30 years, the present worth of the system is \$ 717,900.

TABLE 4-7

ESTIMATED COSTS FOR ION EXCHANGE
TREATMENT SYSTEM

| Item | | Capital Cost (Dollars) | Annual Cost (Dollars) |
|--------------------------------|---|---------------------------|--------------------------|
| A. EQUIPMENT | | | |
| Quantity | Item | | |
| 2 | Strong Anion/Weak Cation Exchange Treatment System | \$ 160,000 | |
| 1 | 2500-gallon Regeneration Waste Storage Tank | 3,000 | |
| 2 | Trailer | \$ 44,000 | |
| B. OPERATION AND MAINTENANCE | | | |
| | ¹ Operation and Maintenance | | 36,000 |
| | ² Power | | 1,800 |
| | ³ Monitoring and Sampling | | |
| | SUBTOTAL | \$ 207,000 | 37,800 |
| C. ENGINEERING AND CONTINGENCY | | | |
| | Design at 15% of Capital Cost | \$ 21,100 | |
| | Construction Management at 5% of Capital Cost | 10,400 | |
| | Contingency at 20% | 41,400 | 7,600 |
| | TOTAL | 289,900 | 45,400 |

PRESENT WORTH

| | |
|------------------------------|--|
| Present Worth Factor (PWF) = | 9.427 (30 years, 10% for annual costs) |
| \$ 45,400/year x 9.427 = | \$ 428,000 |
| 1990 Capital Cost | <u>289,900</u> |
| | \$ 717,900 |

1. Operation and maintenance costs are based on 50 man hours of labor per month at \$ 60/hour.
2. Power estimates are based on two 2 hp process pumps operated continuously at \$ 0.07 per kwh.
3. Monitoring and analytical costs are not included because they are the same for all treatment technologies considered for the IM/IRA.

4.4.3 Organic Contaminant Removal

4.4.3.1. Activated Carbon Adsorption

Description

With a granular activated carbon (GAC) adsorption system, the surface water will be pumped through two GAC columns in series operated in downflow fixed-bed mode (Figure 4-8). A second set of GAC columns will be maintained in stock. Each carbon column is 60 inches in diameter and 87 inches high, and contains 2000 pounds of carbon. Based on a flow rate of 60 gpm, the hydraulic loading to each column will be approximately 3 gpm/ft². The empty bed contact time for each column will be approximately 9 minutes.

To completely utilize the carbon, columns are arranged in series allowing the lead column to become fully exhausted before regeneration while the second (polishing) column ensures effluent quality. Periodic samples will be taken from the effluent of each unit, and when the lead unit effluent exceeds chemical-specific ARARs, the lead carbon column will be removed, the polishing (second) column will become the lead column, and a stock carbon column carbon will be put in service as the polishing unit. The carbon column with the exhausted carbon will then be shipped to an off-site location for regeneration.

Effectiveness

GAC adsorption systems have been shown to remove VOCs from contaminated water to levels that comply with the chemical-specific ARARs. The EPA (*Federal Register*, Vol. 52, No. 130, page 25698) has designated carbon adsorption a "Best Available Technology" for the removal of seven specific volatile organic compounds from drinking water, eg., TCE. This assumes that vinyl chloride, methylene chloride, and acetone are not present at SW-61. It appears from the data that these compounds may be present at the upgradient station SW-56, but at station SW-61 they have always been estimated below detection limits and/or were also present in the associated laboratory blank. These compounds are not readily adsorbed from solution using activated carbon.

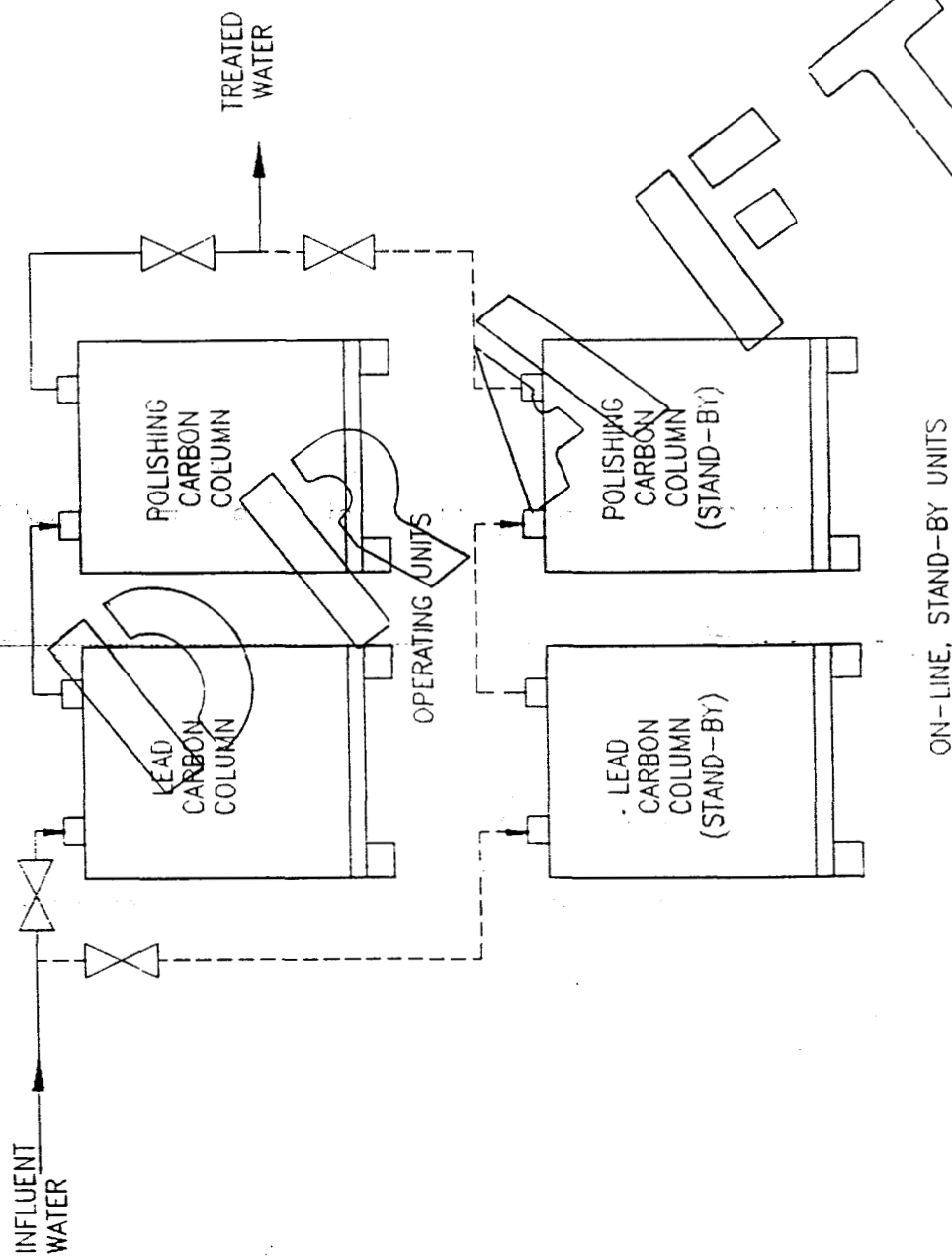


FIGURE 4-8
CARBON ADSORPTION TREATMENT UNIT

The probability of equipment failure will be minimized in this system because of the redundancy of having standby lead and polishing adsorption units in parallel to the operating units, each of which could treat the design flow. Two stock units on site add to the system reliability. Appropriate safety measures required when moving and installing large equipment will be complied with during installation. The operation and maintenance of the system will be by personnel who are trained in the handling of hazardous and radioactive wastes. Wet activated carbon preferentially removes oxygen from the air. Therefore, any time personnel are working in confined areas where oxygen may be depleted, appropriate sampling and work procedures for potentially low-oxygen spaces will be followed, including all applicable federal and state requirements.

The operators of the GAC system will not be exposed to VOC-laden carbon because the use of the containerized and transportable carbon contactors allows removal and regeneration/replacement of the exhausted carbon at a remote carbon reactivation site. Carbon will not be handled at the site. Transporting the entire exhausted carbon column to the regeneration facility ensures operators are protected from the carbon, and the operators need only follow routine safety procedures when handling heavy equipment.

The exhausted carbon is generally regenerated through a thermal treatment process which strips the volatile organics from the carbon. The organics are subsequently destroyed via incineration. During this regeneration process, a small quantity of ash may be generated which requires disposal at a landfill. Thus, this process can be considered an alternative to land disposal since the carbon is continuously recycled. However, if provision is not made for upstream radionuclide removal, the spent carbon will be a mixed waste, and require land disposal at the Nevada Test Site.

GAC adsorption treatment in sealed, fixed-bed contactor vessels does not produce any waste streams or vapor emissions. The safety of nearby communities should not be adversely affected and the risk of harm to the environment should not be increased. This treatment process will effectively remove organic contaminants from the surface water. Treated water will be monitored at the effluent and also at an intermediate point in the system to ensure contaminants are below the chemical-specific ARAR concentrations before being released to the environment during implementation of the process.

Implementability

GAC adsorption is a proven technology for removing volatile organics compounds (VOCs) from water. Testing performed by Calgon (Rockwell International, 1988b) demonstrated that activated carbon can remove VOCs to meet chemical-specific ARARs. A second carbon unit connected in series with the lead unit would serve as a polishing unit and will ensure removal of the VOCs to these levels. The carbon columns can be shipped and readily installed. The system should be ready to operate at full capacity, after initial adjustments and test runs, within a day. Carbon services that provide rental and regeneration of carbon columns will be used. These services are readily available and cost effective for an interim action.

Costs

It is estimated that the carbon usage rate will be 0.6 pounds per 1,000 gallons of surface water, based on breakthrough of 1,1-dichloroethane. This assumes that vinyl chloride, methylene chloride, and acetone are not present at SW-61. Based on a maximum wet surface flow rate of 60 gpm, the annual consumption of carbon will be approximately 20,000 pounds. The cost of a 20,000 pounds per year carbon service is \$ 50,000. This includes the rental and regeneration of 10 carbon columns each containing 2,000 pounds of activated carbon. The cost of round trip shipping is estimated at \$ 3,000 per column. The exhausted carbon columns will be shipped as a manifested hazardous waste.

Using the preceding information, the estimated capital costs for installing a carbon adsorption system is \$ 70,600, and the estimated annual operating costs is \$ 164,900 as shown in Table 4-8. Total cost (Present Worth) of the GAC adsorption system based on 10 percent simple interest, a 30-year duration of operation, and no salvage value, is estimated to be approximately \$1,625,100.

TABLE 4-8

ESTIMATED COSTS FOR GRANULAR ACTIVATED
CARBON TREATMENT SYSTEM

| <u>Item</u> | | <u>Capital Cost (Dollars)</u> | <u>Annual Cost (Dollars)</u> |
|--------------------------------|---|-----------------------------------|----------------------------------|
| A. EQUIPMENT | | | |
| <u>Quantity</u> | <u>Item</u> | | |
| 1 | Process Piping and Pump | 3,000 | |
| 1 | Trailer | 44,000 | |
| B. OPERATION AND MAINTENANCE | | | |
| | ¹ Activated Carbon Service | | \$ 50,000 |
| | ² Shipping | | 30,000 |
| | ³ Power | | 1,800 |
| | ⁴ Operation and Maintenance | | <u>55,600</u> |
| | SUBTOTAL | \$ 47,000 | \$ 137,400 |
| C. ENGINEERING AND CONTINGENCY | | | |
| | Design at 25% of Total Capital Cost | \$ 11,800 | |
| | Construction Management at 5% of Total Capital Cost | 2,400 | |
| | Contingency at 20% | <u>9,400</u> | <u>27,500</u> |
| | TOTAL | \$ 70,600 | \$ 164,900 |

PRESENT WORTH

Present Worth Factor (PWF) = 9.427 (30 years, 10% i for annual costs)
 \$ 164,900/year x 9.427 = \$ 1,554,500
 1990 Capital Cost = 70,600
 \$ 1,625,100

- ¹ Activated carbon service costs are based on rental and regeneration of ten 2,000 pound carbon columns at \$ 5,000 per column.
- ² Shipping costs are based on 10 round trip column shipments per year at \$3,000 per round trip shipment.
- ³ Power costs are based on one 4 hp pump @ \$0.07/kwh.
- ⁴ Operation and maintenance costs based on 77 manhours of labor per month @ \$60/hour.

4.4.3.2 Ultraviolet (UV) Peroxide Oxidation

Description

The UV/peroxide treatment unit as designed by one manufacturer, consists of an 120-gallon stainless-steel oxidation chamber, which provides for a maximum surface water retention time of two minutes at a peak system flowrate of 60 gpm (Figure 4-9).

The oxidation chamber contains six medium pressure UV lamps, which are mounted horizontally in quartz sheaths. A hydrogen peroxide feed system is used to inject approximately 50 mg/l (per ppm of organic contaminants) of a 50 percent H_2O_2 solution into the surface water feed line. The surface water/peroxide mixture then passes through an in-line static mixer before entering the bottom of the oxidation chamber. The water then flows through the reaction chamber, passing the UV lamps, before it exits the top of the oxidation chamber.

Effectiveness

The UV/peroxide system is capable of removing all of the volatile organics from the surface water to levels below the chemical-specific ARARs. Bench-scale studies, using 881 Hillside Area water, were conducted by Peroxidation Systems, Inc. (Rockwell International, 1988b). The bench-scale testing unit provided a dynamic flow simulation of the process to evaluate the parameters necessary to assure treatment effectiveness and unit sizing. Parameters investigated during the testing included hydrogen peroxide (H_2O_2) dosage and power requirements, retention time, system pH, and influent/effluent chemical conditions. Results from this testing provided information on H_2O_2 dosage which has been extrapolated for this application. Contaminant concentrations were reduced to non-detectable levels for initial ground-water influent total VOC concentrations of 1 ppm. These results indicate that the UV/peroxide treatment process is likely capable of achieving the effluent criteria for all of the volatile organics listed in Table 4-1. The volatile organics will be completely oxidized to carbon dioxide, water, and chloride, and no organic degradation products will be produced.

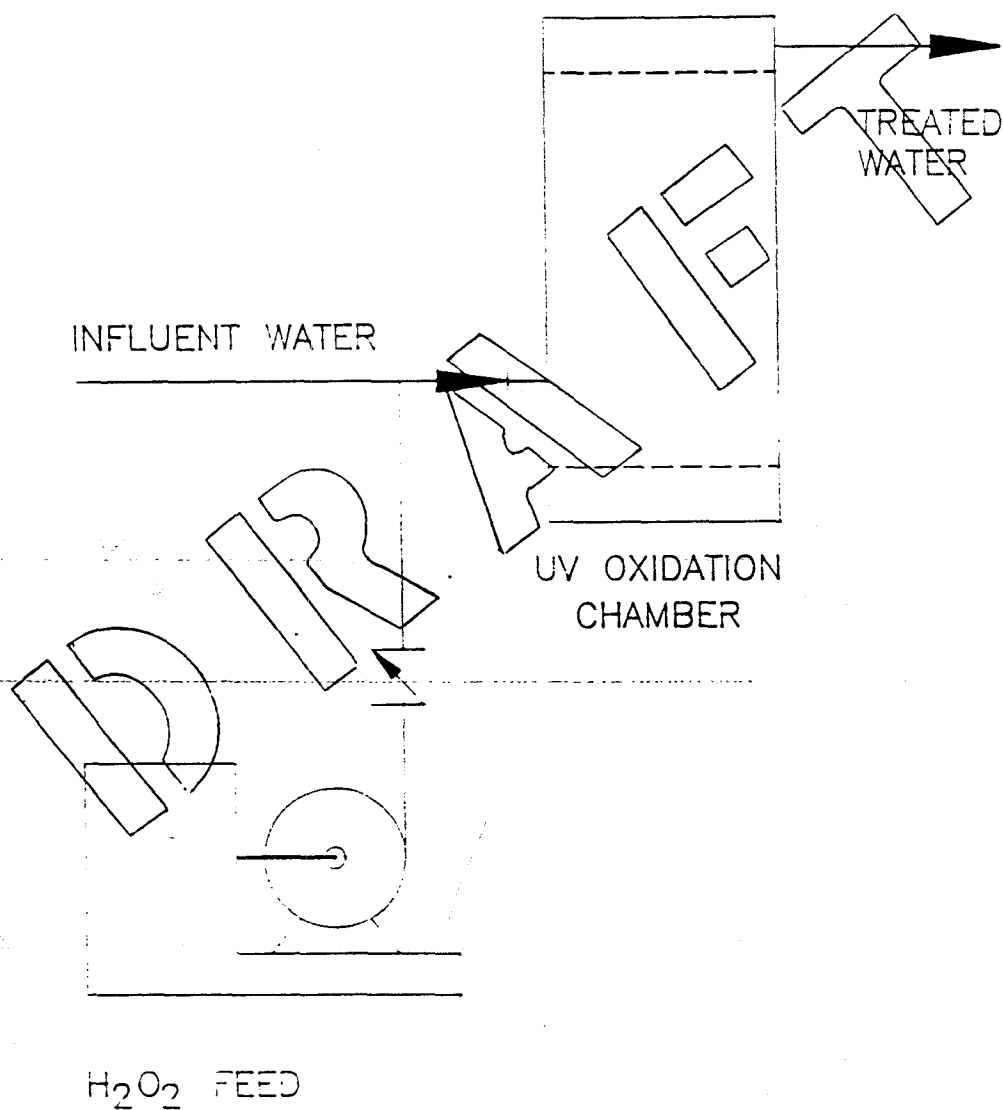


FIGURE 4-9
UV/PEROXIDE SYSTEM

The system requires periodic UV lamp replacement and routine maintenance, and as such is expected to have long-term reliability. The risk of failure of the system at any time is highly unlikely. However, because surface water is expected to have widely varying concentrations of organics, it will be difficult to ensure adequate peroxide dosage for complete organic destruction, and to prevent the appearance of excess peroxide in the effluent. While the presence of ferrous iron can impede the effectiveness of the UV/peroxide treatment system due to the precipitation of ferric iron, the manufacturer has indicated that this will not be a problem at the iron concentrations expected. However, should ferric iron precipitation problems arise, appropriate pretreatment such as aeration will be implemented to correct this problem.

Since the volatile organics are destroyed in the UV/peroxide system, no wastes are produced which require ultimate disposal.

During operation of the UV/peroxide treatment unit, the use of hydrogen peroxide, a strong oxidizer, will require that operators are aware of this potential hazard. The H_2O_2 bulk storage tank will be properly vented to assure no pressure buildup and minimize handling exposure. Existing DOE and EG&G health and safety guidelines at Rocky Flats regarding operator safety while working with strong oxidizers will be followed. UV lamps operate utilizing high voltage, and thus caution must be used when working with the system and during the periodic replacement of the UV lamps.

The safety of nearby communities should not be adversely affected and the risk of harm to the environment should not be increased as this treatment process will effectively destroy the contaminants. Treated water will be monitored to ensure contaminants are within regulatory guidelines before being released to the environment.

Implementability

UV/peroxide oxidation is a technology for the complete destruction and detoxification of hazardous organic compounds in aqueous solutions. Although the technology is relatively new and has had limited application in the field, SARA requires EPA to prefer remedial actions that significantly and permanently reduce

the toxicity, mobility, or volume of hazardous wastes by employing innovative technologies that result in the destruction or detoxification of the wastes.

Demonstrated performance of the UV/peroxide ground-water treatment system has been somewhat limited due to the relatively new development of the process. However, Peroxidation Systems, Inc. has 6 UV/peroxide units currently operational or on-line and ready for operation. One of these units is located at Rocketdyne's Santa Susana facility in California. Pilot scale operations were performed by Peroxidation Systems, Inc., on ground water containing VOCs (TCA, TCE, etc.) at system flow rates of approximately 20-40 gpm. Results from the pilot scale testing were favorable, and a UV/peroxide ground-water treatment unit has been purchased, set-up, and site tested. Another UV/peroxide ground-water treatment system, located locally, was visited and appeared to be a low maintenance, highly effective ground-water treatment unit. This system was treating ground water with TCA concentrations significantly lower than those found at the 881 Hillside (approximately 7 ppb). However, the treatment process had initially and effectively treated ground water with much higher concentrations. Based upon actual bench scale results using 881 Hillside ground water and information received regarding currently operating treatment systems, the UV/peroxide treatment system appears to be a reliable treatment technology.

Operating and maintenance requirements for the UV/peroxide treatment system are relatively minor. The system will require up to 360 kW of power and 12,200 pounds/year of 50 percent H_2O_2 solution for normal operation. Routine maintenance of the equipment is required and the UV lamps will require replacement approximately every 3-6 months. All four system UV lamps can be exchanged in about an hour. The system will require careful observation to ensure the system is operating properly, although system alarms will notify operators if a problem does occur.

Costs

Estimated costs for the UV/peroxide ground-water treatment unit are shown in Table 4-9. Capital cost for the UV/peroxide ground-water treatment system is approximately \$556,800. Operational costs are

TABLE 4-9

ESTIMATED COSTS FOR UV PEROXIDE OXIDATION
TREATMENT SYSTEM

| | | Capital Cost (Dollars) | Annual Cost (Dollars) |
|---|---|---------------------------|--------------------------|
| A. EQUIPMENT | | | |
| <u>Quantity</u> | <u>Item</u> | | |
| 1 | UV Peroxide Oxidation Treatment Unit | 340,000 | |
| 2 | Trailers | 44,000 | |
| B. OPERATING AND MAINTENANCE COSTS¹ | | | |
| | ² Hydrogen Peroxide | | 6,400 |
| | ³ Power | | 73,600 |
| | ⁴ Lamp Replacement | | 10,000 |
| | ⁵ Operation and Maintenance | | 61,200 |
| | SUBTOTAL | 384,000 | 151,200 |
| C. ENGINEERING AND CONTINGENCY | | | |
| | Design at 20% of Total Capital Cost | 76,800 | |
| | Construction Management at 5% of Total Capital Cost | 19,200 | |
| | Contingency at 20% | 76,800 | 30,200 |
| | TOTAL | 556,800 | 181,400 |

PRESENT WORTH

Present Worth Factor (PWF) = 9.427 (30 years, 10% for annual costs)
 \$181,400/year x 9.427 = \$1,710,100
 1990 Capital Cost = 556,800
 \$2,266,900

- 1 Operating costs based upon a flowrate of 60 gpm, 8 hr/d.
- 2 \$0.52/lb x 12,200 lb/yr
- 3 360 KW 8 hr/d @ \$0.07/KWh
- 4 4 times/year
- 5 85 hours per month @ \$60/hour

\$ 181,400 per year and include procurement of hydrogen peroxide, power utilization, labor, and lamp replacement. Operational costs are based on a system flow rate of 60 gpm, 24 hours per day. Assuming a 10% interest rate and a 30 year operating life, the present worth of the system is \$2,266,900

4.4.3.3 Air Stripping with Off-Gas Treatment

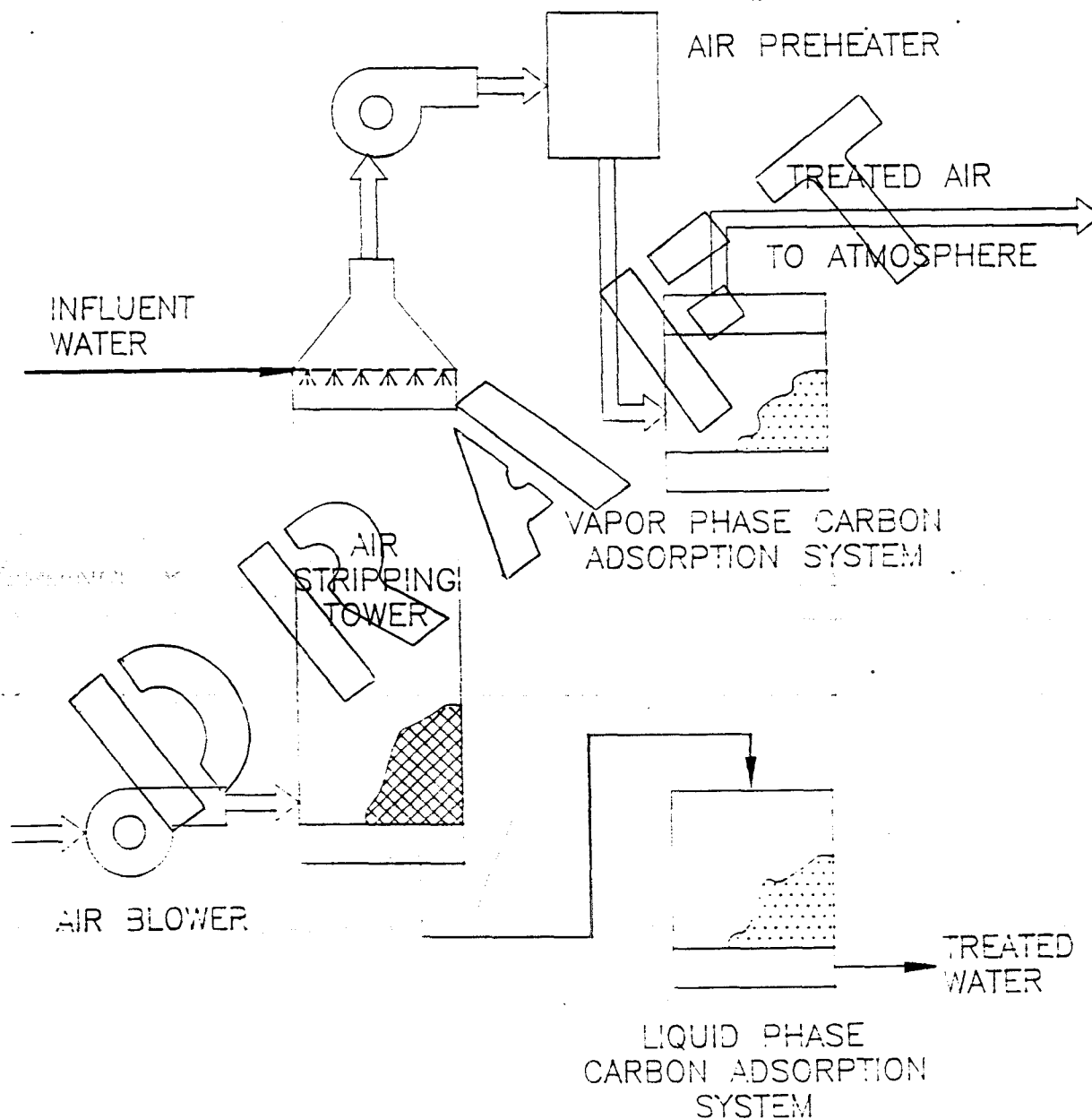
Description

During air stripping, VOCs are transferred from the water to a continuously flowing airstream which is in direct contact with the water (Figure 4-10). Influent contaminated surface water will enter the top of a 32-inch diameter, 34-foot air stripping column and subsequently contact clean air supplied through the bottom of the column (column sizes are approximate). Appropriate air-to-water flow rates will be utilized to provide for the optimum (99+%) transfer of the contaminants from the surface water to the air stream. The treated surface water will then be pumped through a 2000-pound liquid phase carbon treatment polishing unit (identical to the one described in Section 4.4.3.1). The air stripper emissions will be dehumidified by use of a heater, and then passed through a vapor phase carbon system to remove the organics before being released to the environment. The vapor phase carbon unit will contain 2,000 pounds of carbon.

Effectiveness

The use of an air stripper is a highly effective method of removing hazardous volatile organic compounds (VOCs) from water. The efficiency of the process is well documented. The Environmental Protection Agency (Federal Register, Vol. 52, No. 130, page 25698) has designated packed tower aeration along with granular activated carbon, as a Best Available Technology (BAT) for the removal of VOCs from drinking water.

An air stripper coupled with liquid and vapor phase carbon adsorption is a proven system that has a dependable record of use. It is expected that this treatment process, with proper maintenance, will provide the desired level of contaminant removal to meet the chemical specific ARARs.



NOT TO SCALE

FIGURE 4-10
AIR STRIPPING WITH VAPOR PHASE
AND LIQUID PHASE CARBON ADSORPTION

The system is sized for the intended maximum flow of 60 gpm and includes two vapor phase carbon units - one installed and one stock. The on-site stock unit adds to system reliability. All appropriate safety measures required when moving and installing large equipment will be complied with during installation. The operation and maintenance of the system will be performed by personnel properly trained in the handling of hazardous and radioactive wastes. Wet activated carbon preferentially removes oxygen from the air. Therefore, any time personnel are working in confined areas where oxygen may be depleted, appropriate sampling and work procedures for potentially low-oxygen spaces will be followed, including all applicable federal and state requirements.

The operators of the system will not be exposed to VOC-laden carbon from the vapor phase or liquid phase carbon units because the use of containerized and transportable carbon contactors allows removal and regeneration/replacement of the exhausted carbon at a remote carbon reactivation site. Carbon will not be handled at the site. Transporting the entire exhausted carbon column itself to the regeneration facility ensures operators are protected from the carbon itself, and need only follow routine safety procedures when handling heavy equipment.

The exhausted carbon is generally regenerated through a thermal treatment process which strips the volatile organics from the carbon. The organics are subsequently destroyed via incineration. During this regeneration process, a small quantity of ash may be generated which requires disposal at a landfill. Thus, this process can be considered an alternative to land disposal since the carbon is continuously recycled. However, if the spent liquid phase carbon was determined to be a mixed waste, then it would require land disposal at the Nevada Test site. The vapor phase carbon adsorption system will remove the organics from the air stripper emissions before being released to the environment. Therefore, the vapor phase carbon adsorption system will eliminate the impact of any air stripper emissions on the public health. The safety of nearby communities should not be adversely affected and the risk of harm to the environment should not be increased. Treated water and air will be monitored to ensure contaminant levels are below chemical specific ARARs.

Implementability

The air stripper will remove greater than 99% of the contaminants in the surface water. Because the air stripper performance is sensitive to changes in flow and contaminant concentrations, a liquid phase carbon adsorption unit is in series with the air stripper to enhance system performance and to ensure that the treated effluent meets chemical-specific ARARs for volatile organic compounds. Based on a flow rate of 60 gpm, 24 hours per day, liquid phase carbon usage will be approximately 11 pounds/day and each 2000-pound carbon unit will require replacement approximately every six months. Vapor phase carbon usage will be approximately 10 pounds/day and each 2000-pound carbon unit will require replacement approximately every six months.

Operation of the treatment process is relatively simple, requiring occasional cleaning of the air stripping column and replacement of carbon. The air stripper will require cleaning to remove scale buildup on the packing material in order to maintain optimum removal efficiency. Effluent from the cleaning operation will require treatment in the Building 374 Process Waste Treatment System. Transportation and regeneration of the liquid phase and vapor phase carbon units at a remote carbon reactivation site will be required. The air stripping with off-gas treatment system for remediating VOC contaminated surface water is available commercially and could be implemented quickly. No difficulties are anticipated during the installation and start-up of this treatment system.

Costs

Estimated costs for the air stripping ground-water treatment system are shown in Table 4-10. The total capital cost for the system is \$114,800. Operational costs are approximately \$138,600 and include the cost of carbon column rental and regeneration and carbon column shipments to and from the vendor. The carbon column rental and regeneration service described in Section 4.4.3.1 will be used for both the liquid and vapor phase units. It should be noted that the cost of the carbon service is based on regeneration of the carbon as a hazardous waste. If the spent carbon requires disposal at the Nevada Test Site as a mixed waste, these costs could change substantially.

TABLE 4-10

**ESTIMATED COSTS FOR AIR STRIPPING WITH
VAPOR AND LIQUID PHASE GRANULAR ACTIVATED CARBON**

| <u>Item</u> | | <u>Capital Cost (Dollars)</u> | <u>Annual Cost (Dollars)</u> |
|---|---|-----------------------------------|----------------------------------|
| A. EQUIPMENT | | | |
| <u>Quantity</u> | <u>Item</u> | | |
| 1 | Air Stripper Column | 35,000 | |
| 2 | Trailer | 44,000 | |
| 1 | Preheater | 3,000 | |
| B. OPERATING AND MAINTENANCE COSTS¹ | | | |
| | ² Activated Carbon Service | | 38,100 |
| | ³ Shipping | | 15,000 |
| | ⁴ Power | | 1,200 |
| | ⁵ Operation and Maintenance | | <u>61,200</u> |
| | SUBTOTAL | 82,000 | 115,500 |
| C. ENGINEERING AND CONTINGENCY | | | |
| | Design at 15% of Total Capital Cost | 12,300 | |
| | Construction Management at 5% of Total Capital Cost | 4,100 | |
| | Contingency at 20% | <u>16,400</u> | <u>23,100</u> |
| | TOTAL | 114,800 | 138,600 |

TABLE 4-10 (cont.)

ESTIMATED COSTS FOR AIR STRIPPING WITH
VAPOR AND LIQUID PHASE GRANULAR ACTIVATED CARBON

PRESENT WORTH

| | |
|------------------------------|--|
| Present Worth Factor (PWF) = | 9.427 (30 years, 10% for annual costs) |
| \$138,600/year x 9.427 = | \$1,306,600 |
| 1990 Capital Cost = | <u>114,800</u> |
| | \$1,421,400 |

- 1 Operating costs based upon a flowrate of 60 gpm, 8 hr/d.
- 2 Activated carbon service costs are based on rental and regeneration of five 2000 lb columns at \$7,600 per column
- 3 Shipping costs are based on 5 roundtrip column shipments per year @ \$3,000 per roundtrip shipment
- 4 8 hp, 8 hr/d @ \$0.07/KWh
- 5 85 hours per month @ \$60/hour

The total present worth cost of the system based on 10% simple interest, a 30 year period of operation, and no salvage is estimated to be approximately \$1,421,400. These costs do not include any capital or operating costs for the Building 374 Process Waste Treatment System associated with the treatment of the air stripper cleaning effluent.

DRAFT

SECTION 5.0

COMPARATIVE ANALYSIS

5.1 INTRODUCTION

This section summarizes the screened surface water collection and treatment alternatives, and presents a tabular comparison of them (Table 5-1). A recommendation is made for a preferred surface water IM/IRA using the comparative analysis.

5.2 COMPARISON OF TECHNOLOGIES

The following technologies for surface water collection and treatment were evaluated in detail in Section 4:

SURFACE WATER COLLECTION

1. Diversion and collection of contaminated surface water at the sources.
2. Collection of contaminated surface water in existing retention ponds (Ponds B-5 and C-2).

SURFACE WATER TREATMENT

Suspended Solids Removal

1. Advanced Membrane Filtration
2. Contact Filtration

TABLE 5-1

COMPARATIVE ANALYSIS OF TECHNOLOGIES

| <u>Technologies and Present Worth</u> | <u>Effectiveness</u> | <u>Implementability</u> | <u>Comments</u> |
|---|--|---|---|
| Surface Water Collection | | | |
| 1. Collection at Sources \$1,551,100 | Collection at the source will minimize downgradient contaminant transport which otherwise may contribute to contamination of retention Ponds B-5 and C-2. High flow events will transport dilute concentrations of contaminants downgradient. | Easily constructed using conventional equipment. Worker and public health and safety must be ensured through monitoring dust control measures during construction. | Effectiveness outweighs difficulties in implementation. |
| 2. Collection at Existing Retention Ponds \$0.00 | Very effective at prevention of off-site contaminant release because less sensitive to storm flow events. Likely contaminant volatilization, and infiltration into ground water before surface water reaches ponds. | Collection system already exists. Would require treatment system with 10x the capacity of that required for collection at sources. | Less contamination "capture" than source collection, and larger treatment system required. Existing ponds are an effective "backup" to source collection |
| Suspended Solids Removal | | | |
| 1. Advanced Membrane Filtration \$2,494,500 | Should reduce TSS to less than 1 mg/L. Proven technology. Likely to meet chemical specific ARAR for U and evidence suggests ARAR for Pu will also be met. | Reliable based on performance at other installations. Readily available and skid mounted for easy installation. Reasonably simple O&M. | Also removes heavy metals and radionuclides. |
| 2. Contact Filtration \$941,100 | Should reduce TSS to less than 1 mg/L. Proven technology. | Same as for advanced membrane filtration. Solids must be removed from backwash water. | Less likely to meet chemical specific ARAR for U and Pu. |
| Radionuclide Removal | | | |
| 1. Advanced Membrane Filtration \$2,494,500 | see above | see above | see above |

TABLE 5-1 (cont.)

COMPARATIVE ANALYSIS OF TECHNOLOGIES

| Technologies and Present Worth | Effectiveness | Implementability | Comments |
|------------------------------------|---|---|--|
| 2. Ion Exchange \$717,900 | Likely to meet ARAR for U; however, meeting Pu ARAR is very uncertain. | Conventional technology, readily available, and easily installed. If regeneration is required, secondary waste generation with increased operational complexity and cost. | Upstream suspended solids removal necessary which may remove Pu to achieve ARAR. Will remove heavy metals. |
| Organic Contaminant Removal | | | |
| 1. Activated Carbon \$1,625,100 | Will meet chemical specific ARARs for organics provided methylene chloride, acetone, and vinyl chloride are not above ARAR. | Conventional technology, readily available, and easily installed. Upstream radionuclide removal will allow regeneration of carbon in lieu of disposal as a mixed waste. | Data suggest vinyl chloride, methylene chloride, and acetone will not be present above ARAR. |
| 2. Air Stripping \$1,421,400 | Will meet chemical specific ARARs for organics provided acetone is not above ARAR. Methylene chloride and vinyl chloride, if present, are more readily adsorbed on off-gas carbon. Will not remove semi-volatiles or highly water soluble organics (acetone, butanone). | Effective for variable flow and organic loading. Conventional technology, readily available, but installation and operation more complex than liquid phase activated carbon. Off-gas carbon will be necessary to eliminate transfer of contaminants to the atmosphere. Downstream liquid phase carbon necessary to achieve compliance with ARARs for organics because of variable organic loading. | Operationally more complex than liquid phase carbon. Data suggest acetone unlikely to be present above ARAR. |
| 3. UV Peroxide \$2,266,900 | Should meet chemical specific ARARs for all identified organics. | Readily available off-the-shelf units. Less proven technology than air stripping or activated carbon. Effective operation may be difficult with variable organic loading. More costly than air stripping or activated carbon. | Technology of choice for Operable Unit No. 1. IM/IRA; however, influent flow and organic concentration should be relatively constant for that application. |

Radionuclide Removal

1. Advanced Membrane Filtration
2. Ion Exchange

Organic Contaminant Removal

1. Activated Carbon
2. UV Peroxide
3. Air Stripping

Of the two surface water collection alternatives evaluated, diversion and collection of contaminated water at the sources is the preferred methodology for the IM/IRA. Collecting lower volumes of a more concentrated flow is more cost effective and provides better protection of the public health and environment than capturing large volumes of less contaminated surface runoff. The cost effective aspect of this comparison is in the lower capital and operating cost for a smaller associated treatment system. More protection of the public health and environment is afforded because there is less downgradient contaminant transport via surface water or ground water, less volatilization of organics (i.e. release to the atmosphere), and the existing retention ponds provide an effective backup collection system in the event contaminants pass by the source collection systems during storm events.

The advanced membrane filtration technology is the preferred method of suspended solids removal because it is also likely to remove plutonium and uranium from the surface water and generate an effluent that meets chemical specific ARARs for these constituents. Ion exchange cannot be considered a reliable technology for the removal of plutonium because there is no supporting data on its removal efficiency, and plutonium will be colloidal in nature and less apt to readily exchange with ions on the resin surface. Use of the continuous backwash filter will likely remove the particulate plutonium, but removal of dissolved plutonium is less certain, and at times, dissolved plutonium may exceed ARAR (see Table 3-3, flow weighted maximum concentration). The advanced membrane filtration system is reliable, and readily purchased and installed.

Activated carbon is the treatment technology of choice for removal of organic contaminants. It is a proven technology that is reliable, easy to operate, and the most cost effective of the three technologies examined. This technology is not suitable for removal of vinyl chloride, methylene chloride, or acetone. Data for SW-56, a surface water station upgradient of SW-61 which is the point of collection, shows possible contamination with these organics. However, these contaminants have been either estimated below detection limits and/or present in the associated laboratory blanks for samples at SW-61. If acetone is present at SW-61, air stripping will also not be a suitable technology for its removal. Although UV peroxide can oxidize all of these contaminants, effective operation is likely to be difficult with changing organic loadings from a surface water system. Furthermore, UV peroxide is the preferred technology for removal of organics at Operable Unit No. 1, and demonstration of an alternative technology for organics removal for another interim action is prudent for developing a treatment performance data base, and thus adding flexibility in selection and assurance of performance for organics treatment for a final remedial action. Because radionuclides will be removed in upstream unit processes, the activated carbon should not become a mixed waste, and therefore, be suitable for regeneration at any facility that accepts spent carbon for regeneration. This will provide for the ultimate destruction of the contaminants consistent with guidance in the National Contingency Plan that requires consideration of remedial alternatives that include an alternative that removes or destroys hazardous substances.

SECTION 6.0

PROPOSED IM/IRA

6.1 SUMMARY

The preferred IM/IRA for surface water at Operable Unit No. 2 consists of the following components:

1. Surface water collection by diversion at the sources, and
2. Treatment of surface water by advanced membrane filtration followed by liquid phase activated carbon treatment.

6.1.1 Surface Water Collection

Figure 4-2 shows the locations of the surface water diversion and collection systems proposed in this alternative. The collection systems are denoted CS-61, CS-103, CS-55, CS-63, and CS-64. Because of anticipated flow considerations, transport of the water from the collection systems to the treatment plant is by tanker truck for CS-53, CS-55, CS-63, and CS-64 and by pipeline for CS-61 and CS-103.

Upper South Walnut Creek flow will be collected at the downstream station SW-61 by a new surface water diversion weir and pump station (Figure 4-3). The weir will serve to divert up to 38 gpm from the drainage. Contaminated surface water will flow from upstream of the weir through a new rock riprapped channel to a bar screen manhole where large trash is separated from the flow. This screen is of the conventional manually cleaned type and will require occasional removal of trash retained on the screen. The screened, contaminated water will then enter the raw surface water pump station manhole. The pumps installed within the manhole will be of the submersible trash-type of centrifugal configuration, arranged for rail-type mounting and removal, and will be equipped with automatic alternation and start-stop "pump down" controls. Where the inflow into the pump station manhole exceeds the pumping rate, the excess flow will return through overflow piping to the drainage way below the weir.

A diversion weir and pump station similar in design to CS-61 will be used to collect the flow from SW-103. The collection station will be located downstream of SW-103 near South Walnut Creek between Ponds B-4 and B-5. The weir will be designed to pass flows greater than 13 gpm, the previously established design flow rate from seep SW-103. The collected flow will be pumped from a 5000-gallon sump to the treatment facility. Upgradient flow from the Central Avenue Ditch will be diverted from crossing SW-103 by extending the Central Avenue Ditch trench to the east. This flow will be directed downgradient and reintroduced into the South Walnut Creek drainage upgradient of Pond B-5.

The 903 Pad and Lip Area seeps will be collected by CS-55, a newly installed sump at the outlet of SW-55. This collection scheme makes use of the existing surface water diversion pathways and flow described in Section 2.3.5. Installation of a riprap stabilized trench connecting SW-77 to SW-55 will allow collection of the flow from SW-77 in the sump. The sump will be a pre-casted concrete structure with a 5000-gallon capacity. A sketch of CS-55 is shown in Figure 4-4.

The flow from SW-53 will be collected by a system similar to CS-55. A 5000-gallon capacity concrete sump will be located at the outlet of the existing steel culvert which directs SW-53 flow under the firing range access road (Figure 4-4). A sketch of this configuration is shown on Figure 4-4.

Surface water seep SW-63 covers a circular area measuring approximately six feet in diameter. A half-circle shaped trench excavated downslope of the seep will be used to divert seep flow to a sump located at the low point of the trench. The sump will be constructed of concrete and will have a capacity of 5000 gallons. The trench will be stabilized with riprap and soils generated from the excavation will be used to construct a half-circle shaped berm upslope of the seep to divert surface water runoff from the collection system (Figure 4-4).

Surface water seep SW-64 flows into a ditch adjacent to the north side of the site access road shown on Figure 4-1. The seep extends approximately 160 feet within the ditch and a high point in the center of the ditch results in water collection on either side of the ditch. A steel culvert buried beneath the access road at the western side of the seep drains the seep water accumulating on this side of the ditch

downgradient towards the South Interceptor Ditch. A 5000-gallon concrete sump located at the outlet of the existing culvert is used to collect and store this flow. A second 5000-gallon concrete sump is used to collect the seep water flowing east from the high point in the ditch as illustrated in Figure 4-4.

Excavated soils from construction of CS-55, CS-53, CS-63, and CS-64 will be used to construct runoff diversion berms directly upslope of the respective seeps.

6.1.2 Surface Water Treatment

The surface water collected will be treated using advanced membrane filtration (for suspended solids and radionuclide removal) followed by liquid phase activated carbon (for organics removal) (Figure 6-1). The respective units and appurtenances will be housed in three 48 foot trailers to protect weather or temperature sensitive components. Fire protection within the trailers will be provided by two wall mounted 25 pound dry chemical type fire extinguishers. The trailers and all treatment units are constructed of non-combustibles. Other than minimal files and records, no combustible materials will be maintained within the trailers. External water pipes will be above ground and heat traced to protect against freezing. All tanks, piping and sumps will be equipped with secondary containment to comply with 6 CCR 1007-3 and 40 CFR 264.193.

Major components of the treatment system include:

Exterior to the Trailers

- One 10,000-gallon equalization tank
- Piping
- Associated pumps, gages, and valves

Interior to Trailer 1

- main chemical reaction section
- solids dewatering section

Interior to Trailer 2

- filtration section
- process instrumentation section
- neutralization section

Interior to Trailer 3

- (2) 60 inch carbon units
- (2) 60 inch standby carbon units
- associated plastic (PVC) piping and valves

As the flows from the different sources are expected to vary, the equalization tank will ensure a somewhat constant flow and loading through the treatment system. The treatment system is designed to run continuously at a maximum flow rate of 60 gpm. At peak flow these tanks will provide approximately three hours of equalization retention time.

6.1.2.1 Suspended Solids and Radionuclide Removal

When the treatment is initiated, the water will be pumped from the surge tanks to Trailer 1, and subsequently to Trailer 2, which contain all equipment, tanks, pumps, piping, valves, and instrumentation for advanced membrane filtration. The system consists of totally integrated, skid mounted and automatically controlled units for maximum reliability and minimum operator surveillance. The system is divided into various sections as described below.

Main Reaction System Section

Radionuclides and heavy metals will be precipitated and or adsorbed from solution in the main reaction section. The reaction section will include two 1200 gallon tanks, sized to insure complete precipitation or adsorption of radionuclides prior to gravity flow to the filtration section. Chemical metering

pumps, controlled by pH or ORP monitor/controllers will insure that optimum reaction conditions are maintained automatically. The tank will be agitated with a heavy duty electric mixer. The equipment provided in the main reaction section will be as follows:

- (2) 1200 gallon, RFP reaction tanks
- (2) Heavy Duty mixer(s)
- (2) pH monitor/controller
- (2) Chemical metering pump(s)

Ferric sulfate will be introduced to the first tank as a liquid. However, a system will be provided to dissolve the powdered chemical reagent, for controlled introduction into the main reaction section. In the powdered chemical make-up system, a covered tank will be periodically filled with water, and powdered ferric sulfate will be added manually in a prescribed amount. A mixer will be provided to assure that the reagent is completely dissolved before it is delivered by a metering pump to the main reaction section.

Lime will be added to the second tank as a slurry to raise the pH. The elevated pH will cause precipitation of the iron as ferric hydroxide and create conditions conducive to the adsorption of uranium and plutonium. The lime slurry will be prepared by filling a tank with water then adding a prescribed quantity of lime to the tank manually through a chute. The mixture will be well agitated with a heavy duty mixer. The system will be provided with a dust control hood, filter, and fan.

The above peripheral equipment includes:

- (2) 250 gallon heavy duty plastic tanks;
- (2) heavy duty rim-mounted mixers;
- (1) slurry recirculation pump and piping (lime); and
- level control switches and alarms, to be integrated electronically with the main system panel.

Filtration Section

The ferric hydroxide and suspended solids in the reaction section are removed from the water and concentrated in the filtration section.

The main components of the filtration section are:

- (1) 3000 gallon, FRP concentration tank;
- (2) 30 HP, 700 GPM recirculation pump;
- (28) advanced membrane filtration modules manufactured by MEMTEK; and
- (1) piped-in-place membrane cleaning system.

The concentration tank will be made of fiberglass reinforced epoxy equipped with appropriate baffles and liquid level controls. The recirculation pump will be stainless steel for corrosion resistance and rated at 100 feet of head. The pump will be provided with water-flushed double mechanical seals.

The treated water will be filtered through tubular (1" diameter) filtration membranes made of fluorocarbon polymer, and arranged in trains of 10-tube modules piped in series, supported on accessible horizontal racks. Each module will be 6 feet long and 7 inches in diameter, with a separate outlet for clean effluent. A flow indicating and totalizing meter will be provided on the effluent line. Manifolds will be provided to collect the effluent and direct it by gravity to the neutralization system. Volatile organics will be the only contaminants above ARAR passing through the membrane filters. The metal/radionuclide suspension will be concentrated to a 2-5% slurry in the concentration tank, from which it will be periodically pumped to the slurry holding tank and filter press in the slurry dewatering section. The slurry removal rate will be adjusted manually, to maintain the desired solids concentration in the filtration section. All piping and valves in contact with the water being treated will be heavy duty, corrosion resistant plastic.

Neutralization Section

A skid mounted neutralization system will be provided to adjust the effluent pH to the conditions required for discharge or recycle. The neutralization system will be sized to receive and treat the effluent from the membrane filters. The neutralized effluent will leave the system by gravity. The equipment and components of the neutralization system are as follows:

- (1) 1500-gallon heavy-duty plastic tank;
- (1) heavy duty rim-mounted mixer;
- (1) metering pump for acid; and
- (1) separate control panel containing:
 - 1 pH monitor/controller
 - 1 pH recorder
 - pH out-of-specification alarm
 - Electrical switches and contactors

Process Instrumentation Section

A central control panel with a NEMA - 12 rating will be provided to house all controls, electrical switches and disconnects, and motor starters. The main items will include the following:

pH and ORP monitor/controllers/alarms;
Indicator lights, switches and alarms for major components;
Motor starters and circuit breakers for all pumps;
Seal water alarms;
Level controls and alarms; and
Effluent flow indicator/totalizer.

All wiring and controls will meet applicable National electrical codes.

Solid Dewatering Section

The solids dewatering section will include a 4 cubic foot filter press using an air-operated slurry feed pump, to feed concentrated waste slurry from the concentration tank to the filter press. The filter press will dewater the solid to 35-50% solids. Based on the preliminary sizing it is expected that the press will be emptied once every five days. The filtrate produced by the filter press will also be directed back to the concentration tank or the feed sump for reprocessing. A dumpster for convenient handling of the dry filter cake, and an air blowdown system for rapid discharge off the filter press will also be included.

6.1.2.2 Organic Containment Removal

Organic contaminant removal by GAC is a considerably simpler process. After advanced membrane filtration, the ground water will be pumped through two GAC columns in series, operated in downflow fixed-bed mode (Figure 6-1). Two additional GAC columns will be in stock. Each carbon column is 60 inches in diameter and 87 inches high, and contains 2000 pounds of carbon. Based on a flow rate of 60 gpm, the hydraulic loading to each column will be approximately 3 gpm/ft². Empty bed contact time for each column will be approximately 18 minutes. The columns are of stainless steel construction and will be interconnected by flexible pipe with 2-inch camlock hose connections. Once the column is drained of water, the unit is a shipping container for returning the carbon for regeneration.

6.1.2.3 Effluent Discharge

Following treatment, the water will continuously discharge to South Walnut Creek just downgradient of SW-61 and the point of contaminated water collection. Samples will be collected and analyzed twice per week. In the unlikely event that contaminants are present in the effluent at concentrations above ARARs, discharge will cease until the treatment problem will be identified and corrected. In this event, Ponds B-4 and B-5 will also be sampled and analyzed to assess whether their contents can be discharged (via B-5) in accordance with the Plant's NPDES permit.

6.2 OPERATION AND MAINTENANCE

6.2.1 Surface Water Collection

The collection systems are relatively maintenance free. Manholes, sumps, and backwater pools will require periodic cleaning to remove accumulated solids. Pumps will also require routine inspection and maintenance.

6.2.2 Advanced Membrane Filtration

The advanced membrane filtration system's instrumentation and controls will monitor and automatically adjust chemical feed rates. System level switches will automatically operate the feed and process pumps to allow for the continuous flow of surface water through the system. Interlocks and alarms will automatically shut down the system if critical components are operating outside of the design limits. Therefore, the system will be capable of processing surface water with only minimal operator attention. However, operator attention required for the system, estimated at less than two hours per shift, will include these tasks:

1. Maintaining appropriate solids concentration in the concentration tank, by adjusting the amount of waste slurry feed to the dewatering section;
2. Replenishing chemicals as needed;
3. Routine cleaning and calibration of pH or ORP probes; and
4. Periodically initiating the cleaning cycle, and changing the cleaning solution. Typically, a cleaning cycle takes less than 1 hour and is carried out once every 40-80 hours of system operation.

The filtration section includes a cleaning loop, to provide for rapid convenient in-place cleaning of the membrane surface. This includes two 500 gallon polypropylene tanks, an all-plastic cleaning pump (5 HP, 100 gpm at 80 feet of head) and appropriate valves and piping so that the periodic cleaning procedure can be carried out conveniently and quickly. The cleaning procedure will require less than an hour, and is generally done after every 40-80 hours of operations. Actual operating experience will determine the cleaning frequency required for optimum performance of the system. During the cleaning procedure, fresh water is used to flush the waste slurry from the modules back to the concentration tank, and a cleaning solution (usually a strong acid) is circulated through the modules with the cleaning pump for a few minutes. Finally the cleaning solution is flushed from the modules with clean water. Provision is made to reprocess the cleaning solution as part of the normal waste stream, so that only clean effluent leaves the system.

6.2.3 Activated Carbon

Operation and maintenance of the activated carbon system is also relatively simple. To completely utilize the carbon, the columns will be arranged in series allowing the lead column to become fully exhausted for subsequent regeneration while the second (polishing) column ensures effluent quality. Periodic samples will be taken from the effluent of each unit, and when the lead unit effluent exceeds chemical specific ARARs, the lead carbon column will be removed, the polishing (second) column will become the lead column, and a stock carbon column carbon will be put in service as the polishing unit. This is expected to occur every three weeks. The carbon column with the exhausted carbon will then be shipped to an off-site location for regeneration.

6.3 ADDITIONAL DOCUMENTS

In addition to this IM/IRA Plan, EG&G will also be preparing the following documents:

- health and safety plan for construction of the IM/IRA;
- community relations plan;
- detailed design plans and specifications;
- detailed "as-built" drawings incorporating all field changes to accurately reflect the constructed ground water collection and treatment system; and
- an operation and maintenance manual for the IM/IRA.

6.4 RECOMMENDATIONS BEFORE FINAL DESIGN

- Determination of hundred year flood plain for South Walnut Creek as this may influence location of the treatment system.
- Runoff/berm stability calculations for design of all diversion berms.
- Backwater curve calculations for diversion berms at CS-61 and CS-103.
- Treatability study of advanced membrane filtration using existing unit at the Rocky Flats Plant to determine optimum chemical dosing for uranium and plutonium removal.

SECTION 7.0

ENVIRONMENTAL EFFECTS OF THE PROPOSED INTERIM REMEDIAL ACTION

The proposed interim remedial action and subsequent environmental and human health effects resulting from this action are evaluated in this chapter. Environmental impacts to air quality, water quality, terrestrial features (including wetlands), and short- and long-term land productivity are discussed in Sections 7.1, 7.2, 7.3, and 7.4, respectively. Human health exposure risks from installation, routine operations, and accidents are analyzed in detail in Section 7.5 and 7.6. These analyses evaluate the risks to workers involved in the interim action, to other RFP site employees, and to the general public. The commitment of resources (material/human), transportation impacts and cumulative impacts are discussed in Sections 7.7 through 7.9.

7.1 AIR QUALITY

There are three potential air quality impacts associated with the proposed interim remedial action to selectively collect and treat surface water within Operable Unit 2 from surface seeps and surface water monitoring stations. These are:

1. Potential volatile organic chemicals released from exposed contaminated liquids during construction activities (i.e., sump installation, trench excavation) or at surface water collection, storage, and treatment locations, as part of normal operations or accident conditions.
2. Fugitive dusts and fossil fuel consumption related exhausts resulting from activities such as excavation, construction, operations, maintenance, and monitoring.
3. Water treatment process off-gassing released to the environment as part of normal operations or accident conditions.

Air quality impacts from VOCs released during construction activities (e.g., excavation) will be minor when compared to the normal operational activity at the Rocky Flats Plant. Isolated findings of VOCs have been discovered in the area in the form of acetone (up to 480 ppb), trichloroethylene (TCE) (16,000 ppb) and xylene (3,300 ppb) (EG&G, 1990b). Due to their isolated occurrence, and the limited amount of excavation planned, the amount of VOCs released during this construction activity will not cause measurable changes in the ambient air quality. VOC concentrations in soils at Operable Unit 2 are insignificant. Consequently, normal construction activities and excavation for sump installation, buried pipeline/utilities and preparation of the pad

area for the treatment system are not expected to release VOCs to the atmosphere. Preliminary characterization, based on the Phase I RI Report, indicates the presence of elevated concentrations of semi-volatile organic chemicals (phthalates) in the soil. Any airborne releases of semi-volatile organic chemicals will be from fugitive dusts associated with construction activities and will be controlled as discussed below.

Dust associated with construction and operational activities will be controlled as specified in the Job Safety Analysis (JSA) procedures. The JSA is a process developed from the Rocky Flats Health and Safety policy. The JSA addresses health and safety protection of outside contractors and is administered by the Health, Safety, and Environment (HS&E) Department. The initial step of the process involves describing each construction task, identifying potential hazards, and determining the steps to control hazards. This review is evaluated and must be approved by the HS&E Department.

Upon approval of the JSA, the outside contractor is briefed and assigned an RFP construction engineer. This engineer is responsible for construction and arranges for health and safety training for the contractor. This training requires an understanding of the hazards and controls associated with the construction tasks. The HS&E Department will then issue a renewable one-week permit, conditional on the workers being briefed and understanding the safety concerns of the construction effort. The construction is monitored by the HS&E Department for contractor adherence to the JSA.

In addition to these requirements, the Environmental Restoration group has developed wind speed and dust control shut down limits as guidelines for the 881 Hillside Interim Remedial Action. These project document guidelines will also be required for construction at Operable Unit No. 2.

Dermal exposure, inhalation, and inadvertent ingestion of airborne radioactivity and volatile organic chemicals on fugitive dusts is analyzed in Section 7.5, "Personnel Exposure", Pollution from engine emissions, fugitive dust generation by vehicles and particulates from tire wear are analyzed separately in Section 7.8 - "Transportation Impacts".

Collected contaminated surface water will be processed through the proposed advanced membrane filtration system and activated carbon system facility. The aggregate amount of off-gasses from the proposed treatment system will not cause measurable changes in the levels of these gases in the ambient air off-site.

The advanced membrane filtration system incorporated into the water treatment system to remove suspended solids, dissolved metals, and radionuclides will not contribute to off-gassing during normal operations or back flushing operations. Mixing of chemicals for water pretreatment or strong acids or bases used for hardware cleaning operations may contribute to odors within the confines of the water treatment trailers and should be controlled by adequate ventilation. These odors will not be noticeable from outside the treatment facility area, nor will they be a hazard to workers in the trailers under normal circumstances. Spills of chemicals that might be involved in accident conditions will be administratively controlled by actions specified in the Operational Safety Analysis (OSA).

The OSA addresses health and safety concerns originating from routine site operations. It is similar to the JSA in that health, safety, and environmental hazards are identified and evaluated for control. This analysis is also reviewed by and must be approved by the HS&E Department. Training is required prior to operation with oversight and monitoring by the HS&E Department.

Operation and maintenance of the activated carbon system are even less problematic than the advanced membrane filtration system. The carbon columns with exhausted carbon will be shipped to an off-site location for regeneration. Spills of liquids associated with the operation of the activated carbon columns will be limited to the effluent exiting the advanced membrane filtration system which will have removed many of the constituents of concern. The effluent water from the membrane filtration treatment system may contain some amount of volatile organic chemicals.

7.2 WATER QUALITY

Impacts to water quality arising from the proposed interim action are mostly positive. Surface runoff entering excavated areas and exceeding the design capacities of the system could create soil entrainment (sediment transport) by surface runoff ending in open waters on-site.

Some excavation will occur in soils that are expected to have measurable levels of semi-volatile organic chemicals, primarily phthalates. Because phthalates adsorb onto the soil particles and thus are not transferred from soil to water in measurable quantities, surface water runoff should not cause a water quality concern as long as erosion control measures are applied to all soils excavated during remedial action.

Soils surrounding the 903 Drum Storage and 903 Pad Lip sites are contaminated with plutonium and americium (Rockwell International, 1989b). Prior to construction work for the groundwater contamination cleanup, surveys will be performed to detect any presence of elevated radioactive contamination. Elevated radioactive contamination will be handled in accordance with the JSA procedures.

For the advanced membrane filtration system, the greatest potential for water quality impacts results from chemicals involved in the pretreatment of the waste stream and concentrated acids or bases utilized periodically for descaling of equipment. Handling of the concentrated cleaning chemicals will be governed by Operational Safety Analysis, as will the precautions for handling the dewatered solids generated in the water treatment process.

Dewatered solids will be handled as a low-level mixed waste. This will require solidification at an existing Rocky Flats Plant facility to meet the transportation and disposal requirements. The solidified waste will be disposed of at the Nevada Test Site after it is sampled and analyzed to determine compliance with recently promulgated land ban restrictions.

The volume of waste will not be a major addition to those wastes already processed at the Rocky Flats Plant. The collection, transport, and treatment of the dewatered solids will be in accordance with standard plant operating procedures and does not present a significant hazard to on-site or off-site water quality.

The activated carbon adsorption system will provide even less impact to water quality on-site. The carbon columns will be fully self-contained and hold approximately 2,000 pounds of carbon. The units are shipped to an off-site location for regeneration. Approximately one gallon of water per 3-4 pounds of carbon could be spilled during unit change-out of the carbon column. This possibility is mitigated by the use of a

secondary recovery system which captures all of the potentially spilled water. The net effect is that there will be no spill during carbon column change out. Procedures will be established for the safe change out of the exhausted columns. The transport of the exhausted carbon columns will be in accordance with standard plant operating procedures and does not present a significant hazard to on-site or off-site water quality.

7.3 TERRESTRIAL IMPACTS

Terrestrial environment features that may be impacted by the proposed remedial action include animal life, plant life, and land forms (including wetlands). These impacts are expected to be minimal, because the areas of concern have been previously disturbed during the past 37 years since the plant was constructed. These past disturbances have left the 903 Pad with an asphalt pad cap and the East Trenches Area has surface evidence of burial trenches. The impacts of the IM/IRA will not significantly impact the already-disturbed areas.

Excavation for the treatment facility trailers, sumps, and pipelines/utilities will be locally destructive to the vegetation and ground-dwelling rodents, reptiles, and invertebrates. Nests of grassland songbirds may also be adversely impacted by field activities during the breeding season (March - July). The disturbed area, located to the north of the Mound Area, will be small when compared to the total surface area of Operable Unit 2. None of the potentially affected vertebrates, invertebrates, or vegetation in the disturbed areas are threatened or endangered.

The proposed interim remedial action will most likely have an adverse effects on linear wetlands due to the reduced water flow. In 1989, EG&G authorized the preparation of a wetlands assessment for the entire Rocky Flats Plant site (EG&G, 1990a). This report identified 107 acres of aerial wetlands and 84,970 feet of linear wetlands within the Rocky Flats Plant site. South Walnut Creek is identified as one of six ephemeral streams traversing the property and is considered relatively important as part of the site drainage system. The proposed action could potentially impact part or all of the 1,000 feet of linear wetlands due to the removal of up to 38 gpm of water from one segment of this habitat. Although this impact would be small in comparison to the total wetlands on the site, consultation with the Corps of Engineers (COE) is necessary to determine permitting requirements. The COE has determined, based on verbal communications, that no permit is required.

Treated water from the treatment system will be discharged into South Walnut Creek, just downgradient of CS-61 (the surface water collection system of SW-61). The South Walnut Creek basin contains a series of five on-channel reservoirs. The last pond in the series, Pond B-5, discharges directly into South Walnut Creek. Water volume is managed by these ponds and is discharged directly to South Walnut Creek in accordance with a National Pollution Discharge Elimination System (NPDES) Permit. Discharged water follows the South Walnut Creek drainage north to the natural Walnut Creek drainage. Surface water flows in sections of Walnut Creek are currently being diverted around the Great Western Reservoir, a drinking water source for the city of Broomfield, and then returned to the natural drainage channel. Insignificant, if any, impact to wetlands off the Rocky Flats Plant should occur.

7.4 SHORT- AND LONG-TERM LAND PRODUCTIVITY

Land within Operable Unit 2 is currently undeveloped and will remain so for the foreseeable future as part of the Rocky Flats Plant. Operable Unit 2 lies within the Rocky Flats Plant security boundaries and is not accessible to the general public.

7.5 PERSONNEL EXPOSURES - ROUTINE OPERATIONS

The effects of personnel exposures to hazardous chemicals have been estimated in terms of increased risks to individuals of either developing cancer (carcinogenic risk) or developing some other adverse health effect due to the exposure (noncarcinogenic risk). Analyses were done separately for those directly involved in remedial actions (workers), other Rocky Flats Plant personnel not directly involved in remedial actions (site employees), and offsite individuals (general public).

Estimates of carcinogenic risks were calculated for each of the organic chemicals identified in Table 4-1, and the individual risks summed for a total carcinogenic risk. The carcinogenic risks are considered to be cumulative for the entire period of exposure, and the calculations yield an estimate for the lifetime increased risk of cancer.

Noncarcinogenic risks are considered "threshold" events. That is, no effect is observed below a given exposure. Increased risks are based on the average long-term exposure (chronic exposure) and are not cumulative over the exposure period. Chronic exposure levels were averaged over the period of the release or over one year (whichever was shorter) for each of the selected chemicals through each pathway. These levels were evaluated by comparing predicted daily contaminant intakes to the Health Effects Criterion (HEC) (the daily exposure level below which no adverse health effects are expected to occur). HECs used in this report are Reference Doses (RfDs) as developed by the U.S. Environmental Protection Agency.

Exposures to site employees and members of the general public were analyzed based on a single, hypothetical individual for each exposure category. Site employees were assumed to be assigned eight hours a day for the duration of the release to whatever building would receive the greatest average airborne exposure. For the proposed action, the nearest occupied locations resulting in the greatest exposure to other site personnel include Building 991 and the Gate 9 guard post (inner guard post on each access road). The analysis of the impact to the general public assumed a single individual would remain at the point of highest exposure (due east at plant boundary) accessible to the general public for each pathway, twenty-four hours per day, for the entire duration of the release. These calculations provide an upper bound for the increased risks to an individual from each of these groups. During the remedial action, it is unlikely that any worker, site employee, or member of the general public would exceed or even approach the risks estimated for their respective group.

In calculations of the estimated increased risks to members of the general public from hazardous chemicals, the impacts on infants and young children were calculated separately from those on adult members of the population. Infants and young children differ from adults in the rate of uptake of the hazardous chemicals and in body weight. Both of these factors influence the calculations of increased risk. To assess noncarcinogenic risks, exposures to the chemicals were estimated for both children and adults and compared with the HEC. The numbers quoted in the text of this document are those for the group with the greatest increased risk. Carcinogenic risks to a member of the general public were estimated assuming exposure for the entire length of the release, which was assumed to be thirty years. Two exposure categories were considered: one where the member of the public is already an adult when the project starts and the other where the individual is assumed to be a child for the first five years of remedial action and an adult for the

remaining 25 years. The numbers in the report represent whichever analysis yielded the highest increased risk of cancer.

The intake of radioactive materials has been assessed by calculating total intake by individuals and converting that to Committed Effective Dose Equivalent (CEDE) using the exposure-to-dose conversion factors for inhalation (Table 2.1 of EPA, 1988). Internal Dose Conversion Factors for Calculation of Dose to the Public, Part 2 (DOE, 1988b), was used to assess doses to the public. The calculated values for CEDE are then compared with the DOE limits of 5 rem per year for workers (DOE, 1988c) and 100 mrem per year for members of the general public (DOE, 1989).

7.5.1 Worker Exposure Risks

Workers involved in the installation of collection facilities and those involved in operation of the facilities associated with the remedial action may experience increased risks through several pathways:

1. Airborne exposure to volatile organic chemicals (VOCs) near construction activities, equipment installation, or within the facility.
2. Dermal exposure to organic and inorganic chemicals or radioactive materials, especially during construction activities.
3. Inhalation of organic chemicals, inorganic chemicals, or radioactive materials on fugitive dust, especially those generated during construction activities.

Airborne Exposures

It is proposed that the treatment facility be located at the north boundary of the Mound Area. Associated piping and utilities will be located outside all existing SWMUs to avoid, to the degree possible, soil contaminated with VOCs. There will be monitoring to assess possible exposures to VOCs during these construction activities. Protective measures appropriate for the level of VOCs detected will be specified in the

Job Safety Analysis (JSA) to protect the workers. The JSA is a process developed from Rocky Flats policy and administered by the Health, Safety and Environment (HS&E) Group to address health and safety concerns encountered by outside contractors. The initial step of the process involves describing each construction task, identifying potential hazards, and determining the steps to control hazards. This review is evaluated and must be approved by the HS&E Group. Upon approval of the JSA, the contractor is briefed and assigned an EG&G construction engineer. This engineer is responsible for construction and arranges for health and safety training of the contractor. This training requires an understanding of the hazards and controls associated with the construction tasks. EG&G will then issue a renewable one-week permit, conditional on the workers being briefed and understanding the safety concerns of the construction effort. The construction is continually monitored by the EG&G HS&E Group for contractor adherence to the JSA.

The potential for chronic or routine exposure of workers to VOCs resulting from operations and maintenance tasks will be small. Operational Safety Analysis (OSA) procedures will be established to control potential hazards to workers. The OSA addresses health and safety concerns originating from routine operations. It is similar to the JSA in that health, safety and environmental hazards are identified and evaluated for control. This analysis is also reviewed by and must be approved by the HS&E Group. Training is required prior to operation with oversight and monitoring by the HS&E Group.

The treatment facility trailers will be ventilated to prevent the buildup of VOC vapors in the work environment. The process reaction, concentration, and neutralization tanks will be equipped with hinged covers to minimize the introduction of VOC vapors into the work area. The filtration, dewatering, and carbon adsorption units are closed systems and thus will not act as VOC vapor sources. Periodic (every 1 to 3 days) removal of dewatered solids (sludge) from the dewatering equipment will be necessary. This will require opening of the filter press housing and potential short-term exposure to VOC vapors. Facility ventilation and OSA procedures will provide appropriate personnel protection. The wet consistency of the sludge will preclude potential aerosolization of radioactive particulates and associated exposure from inhalation. The dewatered solids will be handled as a low-level mixed waste. Outdoor operational tasks, such as transport of contaminated water from selected collection systems (CS-53, CS-55, CS-63, and CS-64) to the treatment facility, will be performed in accordance with the appropriate OSA.

Activities that might lead to nonroutine exposures, such as opening tanks or other maintenance operations, will be of short duration and will not lead to chronic exposures. Monitoring these activities will be necessary, however, to determine that adequate protective measures required to assure that workers were not exposed to VOC levels exceeding appropriate limit for the individual chemicals.

Dermal Exposures

As with airborne exposures, potential dermal exposures will be controlled with the implementation of JSA and OSA procedures. Potential levels of protection from splashing and contact with contaminants include the use of gloves, protective clothing, goggles, and hoods.

During construction activities for the proposed action, there will be little or no potential for dermal contact with soil contaminated with VOCs. The treatment facility will be constructed at the north boundary of the Mound Area, where VOC contamination levels are anticipated to be low. The piping for the water treatment facility will be routed through uncontaminated soil. All excavation for the collection stations, except for SW-61, are not expected to involve removal of damp soil which may be contaminated by VOCs. Any excavated damp soil will be treated as a RCRA mixed waste until determined otherwise. Inorganic chemicals and radioactive materials identified in the work areas are not readily absorbed through the skin and would result in a negligible exposure pathway.

Personal protective measures may be necessary during some routine operations activities where there is a potential for contact with contaminated water (e.g., routine water sampling or solids removal in the treatment facility). If such measures are necessary for the protection of the workers, they will be specified in the OSA for those activities.

Inhalation of Fugitive Dust

Fugitive dusts are likely to be generated during construction activities or during operation of the water collection and treatment facilities. The Phase II Sampling Plan (DOE, 1989b) includes soil sampling in the areas of interest, but the results are not yet available. For this reason, the surface soil conditions have been

estimated using available soil samples from the Phase I RI/FS (Rockwell, 1987a). Where soil samples were not available, the nearest soil samples located between the area of interest and the most likely source of contamination have been used.

The soil samples indicate that the only organic chemical found in soil above the water table is bis-(2-ethylhexyl)phthalate. The EPA Health Effects Assessment Summary Tables (EPA, 1989) list reference doses (RfDs) for oral intakes of bis-(2-ethylhexyl)phthalate but not for inhalation. Consequently, the only contaminants of significant concern from the fugitive dust pathway are plutonium and americium. The estimate of plutonium in the surface soils for collection systems CS-63, CS-64, and CS-103 was taken from the 1988 Annual Environmental Monitoring Report (Rockwell, 1988c). Plutonium in the surface soils for collection systems CS-53, CS-55, and CS-61 are based on data from the nearest available boreholes. These boreholes are located within the 903 Pad Lip area where the contamination levels are expected to be much higher than at the location of the collection systems. In soil samples where both americium and plutonium were reported, the americium contamination levels averaged 13.5 percent of the levels of plutonium contamination. In these calculations, it is assumed that americium is equal to 15 percent of the reported plutonium contamination level.

To calculate conservatively high dose estimates, the uptake of fugitive dust by the workers was based on a continuous exposure to an airborne dust loading of 10 milligrams per cubic meter of air, the maximum dust loading permitted by OSHA regulations for nuisance dust. It was estimated that the construction work will continue for sixty calendar days. Assuming no respiratory protection and exposure of workers eight hours per day, five days a week for the full sixty calendar days, the maximum dose to a worker would be 0.4 rem CEDE. A breathing rate of 9.6 cubic meters per eight-hour shift (ICRP 23) was used in the calculation.

Actual occupational construction exposures are anticipated to be less than those calculated above. Dust control measures will be specified in the JSA to further limit inhalation exposures. Control measures may include premoistening of excavation areas and continued moistening during excavation.

Transfer of contaminated surface water by tanker truck results in a fugitive dust source term during operations. While the fugitive dust generated in the wake of the vehicle may provide an exposure pathway for

other site workers and the public, it is not expected to be a significant exposure pathway for the vehicle operator.

7.5.2 Site Employee Exposure Risks

Other workers at the RFP site could be exposed to low levels of VOC vapors released during normal operation and to fugitive dust generated both during installation and operation of the facilities associated with the proposed action.

Although the vent on the feed equalization tank (see Figure 6-1) on the water treatment facility will have an activated charcoal filter attached, a calculation was performed to determine the potential VOC releases from the vent without a filter attached. Since that tank is the largest single tank in which untreated water is collected, it was chosen as the tank which, if unfiltered, could lead to the greatest exposures to other site employees or the public. Any other tanks, sumps, or pump vents would lead to lower exposures and lower risks. In the calculation, it was assumed that the liquid in the tank was at the contamination levels listed in Table 4-1 and that the vapor in the tanks had reached equilibrium with the liquids. It was further assumed that the vapors are displaced by inflowing liquids at an average rate of 60 gallons per minute, the design processing rate. That is, it is assumed that the average liquid inflow must equal the processing flowrate, but no credit was taken for water being removed from the tank. Under these circumstances, the maximum total carcinogenic risk factor for other site employees would be 5×10^{-10} and the maximum total noncarcinogenic risk would be 2×10^{-9} .

There will be dust generated during the construction of the water collection facilities as well as the water treatment facility. The dust generation rate was estimated using the construction generation rate of 1.2 tons per acre per month from AP-42 (EPA, 1985). It was assumed that the project would create dust over an average area of one acre for two months. This led to a calculated average generation rate of 4.2×10^{-4} kg of dust per second. To be conservative in calculating the exposure of site employees, it was assumed that all the dust was generated at the water treatment facility site since that would produce the maximum exposure to the personnel at the inner east guard post (located at the intersection of East Road and the Northeast Access Road). The approach utilized to estimate airborne contamination levels due to fugitive dust has been discussed in the fugitive dust portion of Section 7.5.1 of this report. Using the average dispersion coefficient

(x/Q) from the water treatment facility to the guard post of 8.46×10^{-5} seconds per cubic meter, it is estimated that an individual assigned to that guard post for the full sixty day duration of the construction activities would receive a maximum dose of 0.9 millirem CEDE.

Unlike the construction activities that are of limited duration, operational activities that might generate respirable dust would continue for the lifetime of the action. The principal such action would involve transportation of the water collected at collection sites CS-53, CS-55, CS-63, and CS-64 to the treatment facility. Again the closest continuously occupied building is the guard post. The value of x/Q is different, however, because both the distance to the area where the dust is generated and the wind direction to carry it to the guard post are not the same as during construction activities. The calculated average value for x/Q for this exposure case is 1.58×10^{-5} seconds per cubic meter. The dust emission rate was calculated using the equation for fugitive dust from travel on unpaved roads from AP-42⁶. It was assumed that transport would be by a thirty ton tanker truck traveling at an average speed of twenty miles per hour on gravel roads for an average of twenty miles per week, fifty-two weeks per year. The same soil concentration was used as described in Section 7.5.1 of this report. Under these circumstances, it was calculated that the dose to someone assigned to the guard post eight hours a day for the full year would receive a maximum dose of less than 80 mrem CEDE per year.

7.5.3 Risks from Exposure to Members of the Public¹

Members of the public could be exposed to the same sources of risk as described in the previous section for other RFP site workers. The airborne concentration of the fugitive dust would be less for members of the public because of the greater dispersion distance from the source.

The public may be exposed to fugitive dust containing plutonium and americium generated during both the construction and operation phases of this action. Doses to the public were analyzed for two sources of dust discussed in Section 7.5.2 above. The maximum activities would be about 0.01 mrem. The doses from

¹ Throughout this report, the term "general public" has a special and very restricted meaning. In order to estimate the maximum exposure or risk to any individual outside of the RFP site, all estimates are based on exposure to a person at the site boundary location having the highest average airborne concentration who remains there for 24 hours each day, 365 days each year, for the duration of the operation or the remedial action.

dust generated during vehicular travel for water collection would add about 4 mrem per year. These are both very low compared with the dose from natural sources of radioactivity in our environment (about 125 mrem per year) or to the DOE guidelines of 100 mrem per year to any member of the general public (DOE, 1989).

As discussed in section 7.5.2, potential VOC releases from the feed equalization tank were analyzed to provide an upper bound on the risks from releases from other, unfiltered tanks. Using the same assumptions as described in section 7.5.2, the maximum total carcinogenic risk factor for a member of the public would be 7×10^{-7} . The maximum total noncarcinogenic risk would be 2×10^{-10} to the same individual.

7.6 PERSONNEL EXPOSURE - ACCIDENT

Any accidents that may occur during the construction phase of the proposed action are those typical of small excavation or construction activities. The Job Safety Analysis (JSA) will identify appropriate precautions and responsibilities for each basic job. Workers will be familiar with the JSA and a copy of it will be available at work site. No credible accident during construction would lead to exposure of either workers, site employees, or members of the public to levels greater than those resulting from the severe accident case analyzed below.

During operation, accidents that could impact either workers or members of the public would include fires or major spills of contaminated material. Spills of untreated water within the treatment facility would create the potential for short duration airborne VOCs. Uptake of contaminants by workers involved in the cleanup would be controlled by following safety precautions specified in the Operational Safety Analysis. any airborne VOC releases through ventilation systems that could lead to exposures of other RFP employees (site employees) or the general public would be less than the tank rupture discussed later in this section.

The initiation and propagation of fire within the treatment facility is a credible accident. The facility trailers are equipped with chemical fire extinguishers; however, the trailers will not normally be occupied. Any VOC releases would be bounded by the severe accident case since concentrated VOCs would be contained

within the activated charcoal columns which are closed components and filled with water. Solids which are in the filter press housing or which have been removed and placed in metal containers constitute a potential radioactive material source term. A fire would have to both dry out and aerosolize the solids as well as breach the metal containment to result in a radioactive release. In as much as the solids are inorganic and in a sludge form containing 60 to 70% waster and are within metal containers, and that the trailer is the only major combustible material present, it is concluded that the fire duration and intensity would be insufficient to result in a radioactive material release resulting in any significant impacts.

The most severe credible accident with potential for the exposure of either site employees or the public would be airborne VOCs released with the rupture of the 10,000-gallon water collection tank. The analysis of this hypothetical accident assumed the tank to be full of water at the design basis concentrations shown in Table 4-1. It was further assumed that all the contents are spilled and all VOCs off-gas completely within the first twenty-four hours following the spill. The analysis indicates the total increase in carcinogenic risk to the maximally exposed member of the public would be less than 2×10^{-10} or about two hundredths of one percent of the level considered significant by the EPA. The total increase in the noncarcinogenic risks would be about 7×10^{-7} or about seven billionths of the level considered significant by the EPA. For other site workers, the carcinogenic risks would be about 2×10^{-9} (less than one hundredth of the level the EPA considers significant). The noncarcinogenic risks to other site workers would be 2×10^{-5} (about two thousandths of one percent of the level the EPA would consider significant) if no efforts were made to evacuate or otherwise protect the workers downwind of the spill.

7.7 COMMITMENT OF RESOURCES

The scope of the proposed interim remedial action is small and the resources (material/human) for construction and operation of this surface water treatment system will likewise be small. No significant commitments of valuable resources are involved.

With the exception of the land area, all of the materials for construction and operation of the water treatment system will be irrevocably and irretrievably committed to the implementation of the remedial action. Most of these resources are normally consumed at the plant at a rate which makes the requirements of the

remedial action insignificant. The water pretreatment chemicals and cleaning solutions are already in use at the RFP. The chemicals for the advanced membrane treatment system and the carbon canisters are all readily available from off-site sources. The anticipated use of process chemicals, cleaning agents, and carbon will all be well within local supplies.

7.8 TRANSPORTATION IMPACTS

Human health impacts normally incident to transportation include vehicle emissions in addition to possible traumatic injuries and fatalities resulting from vehicular operations. Normal transportation for the proposed action consists primarily of a single water truck (5,000 gallon capacity) collecting water from specific sources on a scheduled basis. Total mileage is expected not to exceed 20 miles per week. In addition, a slight increase in emissions might result from pumping actions associated with on-loading and/or off-loading the water truck.

Normal transportation produces engine emissions, fugitive dust generated by vehicular traffic on unpaved surfaces, and particulate from tire wear. The table below presents an estimate of emission rates for the operation of a typical water truck.

WATER TRUCK EMISSIONS RATE

| <u>Pollutant</u> | <u>Emission Rate (lbs/100 gal. fuel)</u> |
|------------------|--|
| Hydrocarbons | 13.1 |
| NOx | 286.0 |
| SOx | 31.2 |
| CO | 123.5 |
| TSP | 17.7 |

The impacts on health resulting from transportation during the proposed action includes the potential for both pollution and accident related impacts. The table below presents estimates of risks resulting from truck transportation (Rao, 1982).

HEALTH EFFECTS PER KILOMETER

| <u>Source</u> | <u>Mode</u> | <u>* LCFs</u> | <u>Injuries</u> | <u>Fatalities</u> |
|---------------|-------------|---------------|-----------------|-------------------|
| Pollutants | Truck | 1.0 E-7 | | |
| Accidents | Truck | | 5.1 E-7 | 3.0 E-8 |

* LCF = Latent Cancer Fatality

Uncertainties are associated with pollution emission rates and atmospheric dispersion behavior. To compensate for these uncertainties, the analysis used conservative estimates for determining pollution health effects. The tabulated accident impacts are average values over all population zones (urban, suburban, rural) and are derived from nationwide Department of Transportation statistics.

The proposed action will involve transportation activities during the construction phase as well as during subsequent operations. All construction shipments are anticipated to be by truck and originate within the Denver metropolitan area, within a 50-mile radius of the plant site. Materials to be brought on-site include the treatment systems, storage tanks, piping, concrete, and associated equipment. The delivery of these materials will require several truckloads over the construction period, followed by routine transport travel between collection areas and the treatment facilities estimated at less than 20 miles per week. The resulting transportation impacts will be small, as seen from the tabulated emissions and health effects estimates. To place transportation impacts to the general public in perspective, it is observed that approximately 60,000 round-trip truck shipments (one-way distance of 50 miles) would be required to result in one additional latent cancer fatality (LCF). An average of 210,000 truck shipments would be required to result in one additional traumatic fatality. The increase in site travel during construction may be noticeable, but will be of short duration. Outside the plant boundary, the increase will not be noticeable.

Treatment of contaminated surface water from the Operable Unit 2 will result in an incremental increase in site pickup and deliveries of spent carbon columns and replacement units and chemicals for the pretreatment of water for the advanced treatment membrane system. Deliveries will be spread out over the course of the

year and will be handled by one of the existing plant chemical suppliers. The very small number of shipments involved for both the carbon columns and the advanced treatment membrane system will result in an insignificant impact to human health.

Operational activities will also include periodic inspection of the collection system to remove trash or other obstacles as well as routine inspection of the pipeline system providing direct feed to the water treatment facility. This will require vehicular travel to each source area, which is estimated to total 20-30 miles per week. Impact to human health (latent cancer fatalities from vehicular pollution) will be negligible.

7.9 CUMULATIVE IMPACTS

Routine processing of the surface water gathered from the surface seeps, and drainages will result in some additional solid wastes being generated from the site. With a peak flow estimated to be approximately 75 cubic feet per week, the semisolids from the advanced membrane treatment system will be treated on site and shipped to the Nevada Test Site for final disposal. The annual production rate of the semisolid will average much lower. All gaseous releases will be undetectable off-site. None of the materials that may be released are expected to be concentrated by any natural process.

The drying of the semi-solid sludge waste from the treatment system will require an increase in plant solidification operations to dry and package the waste for transport to the Nevada Test Site. Neither the drying nor packaging requirement will add significantly compared to the current workload of the facility. Radionuclide accumulation in the sludge is not expected to exceed exempt quantities by weight, so that shipment of the sludge is not expected to cause any special concern or unusual controls.

It is estimated that four workers will be involved in routine operation and maintenance of the surface water collection treatment facility. This will have negligible impact on the workload of plant personnel. In

routine operations, these workers will not be exposed to any levels of chemicals or waste stream pollutants that would restrict them from other assignments at the Rocky Flats Plant.

Construction activities will result in increased vehicular traffic, engine emissions, and the number of workers. The number of personnel required for the proposed action will be a small increase to the assumed yearly additional construction loading.

Discharges of treated water into the South Walnut Creek basin may total up to 600,000 gallons per week during peak flow. After surface water loss due to percolation and evaporation, additional discharges may be necessary from the B-5 pond. These discharges, in addition to the current NPDES discharges, are not expected to impact Walnut Creek downstream of the B-5 pond.

SECTION 8.0

ENVIRONMENTAL EFFECTS OF THE ALTERNATIVES

The preferred alternative and the proposed action for this interim remedial action is to gather the contaminated water from a series of point sources and process the water through a water treatment system. The preferred treatment system consists of an advanced membrane treatment system for removal of radionuclides and metals, followed by a carbon column system for removal of VOCs. The treated water will then be returned to South Walnut Creek.

Several alternatives to the proposed IM/IRA were evaluated for environmental effects. The alternatives included: 1) no action; 2) evaluation of surface water collection alternatives; and 3) evaluation of different surface water treatment technologies. Each alternative is evaluated in regard to environmental quality, personnel exposure and transportation impacts. Following the alternative evaluation, Table 8-1 compares the potential impact of the proposed action with the alternatives.

8.1 ENVIRONMENTAL EFFECTS OF NO ACTION

8.1.1 Environmental Quality

The No Action alternative would not involve any short-term impact to the environment or the work force/general population and would eliminate the need for off-site transportation activities. However, it would not contain, remove, nor destroy any radionuclides, volatile organic compounds or inorganic contaminants. The No Action alternative would pose a long-term release risk to the general public and would require remedial actions in the future.

The No Action alternative would require that the current quarterly site monitoring be continued. Because the monitoring is a part of the existing plant environmental monitoring program, the impact on plant operations and the surrounding community would be effectively zero. However, because off-site migration may occur in the future and because Federal and state regulations require remedial action, the No Action alternative is unacceptable.

8.1.2 Personnel Exposure

The No Action alternative will have impact on current workers at the site or at adjacent sites. Workers would be required to collect quarterly sampling, which would present no additional impact. Therefore, the possibility of releasing contaminated water off-site would increase over time. The site would then be a source of public exposure in the long term.

8.1.3 Transportation

The No Action alternative would allow for continued seepage of contaminated water that would migrate through existing flow pathways and into retention ponds B-5 and C-2 allowing for possible future site contamination. Since no remedial action would occur under this alternative, there would be no on-site or off-site transportation activities associated with this alternative or related impacts to workers or the general public.

8.2 ENVIRONMENTAL IMPACTS OF ALTERNATIVE 2

8.2.1 Environmental Quality

In addition to the proposed action of collecting contaminated surface water at its source, one alternative is to collect Operable Unit No. 2 surface waters from Pond B-5 and C-2. Although this would greatly simplify the logistics of gathering the contaminated surface water, it would also allow for contaminant migration downgradient from the seeps and monitoring stations. This would result in increased exposure to the environment, especially from volatilization of organic compounds into the atmosphere. Under this alternative, existing or modified ditches would gather the contaminated water and deliver it to a centralized wastewater treatment system. Because these ditches are unlined, contaminants from the surface water in the ditches would percolate downward through the soils, creating additional contaminants that would require cleanup at a later date.

8.2.2 Personnel Exposure

Installation of this collection system rather than the proposed alternative would reduce the short-term potential worker exposure to volatile organic compounds and radioactive fugitive dusts by reducing the amount of excavation required to install the water treatment facility. The worker exposure in the long-term, however, could be increased because of the eventual need to return to the area and clean up the ditch system used for transport of wastewater under this alternative.

During operation of this alternative, worker's exposure risk to volatile organic compounds and radionuclides is reduced in the short-term but potentially increases in the long-term due to the additional contaminants potentially deposited in the surface drainage channels.

8.2.3 Transportation

Installation of this alternative would reduce the potential transportation impacts due to the reduced need of equipment to install the pipeline collection system. Transportation gains in the short-term are overshadowed by the potential long-term losses that would result by the additional contamination. Long-term transportation impacts would require equipment to gather the contaminated soils and may still require the installation of a pipeline collection system at a later date.

8.3 ENVIRONMENTAL EFFECTS OF ALTERNATIVE 3

8.3.1 Environmental Quality

A variety of treatment technologies were investigated as an alternative to the proposed action. These included contact filtration for suspended solids removal and ion exchange for radionuclide removal. In addition, ultraviolet (UV) peroxide oxidation and air stripping with off-gas treatment were examined for organic contaminant removal. Many of these treatment systems are in use today for treatment of contaminated surface and ground water containing similar constituents to the Rocky Flats surface water contaminants. A problem exists, however in finding documented evidence of a system capable of removing plutonium. A search of

technical literature and contact with individual vendors produced no concrete data on the ability of these technologies to remove plutonium. Limited data is available for the removal of plutonium from natural surface water. Although these alternative technologies have the potential of having a smaller environmental impact, the inability to prove so, without extensive testing, eliminates them from further consideration.

8.3.2 Personnel Exposure

The use of alternate treatment technologies would have little impact on the personnel exposure associated with surface water cleanup. The contaminants in the water remain the same and the removal techniques are essentially similar with respect to personnel exposure a risk.

8.3.3 Transportation

The selection of one of the alternative treatment technologies may cause an increase in transportation requirements, dependent on the rate of water treated and the contaminants to be removed. The ion exchange columns utilize resin beads that may require periodic replacement. The increased transportation for this alternative would be minimal.

8.4 SUMMARY

The impacts of the alternatives are judged to be small. The potential impacts associated with the proposed action and each of the identified alternatives are presented in Table 8-1-A through C.

TABLE 8-1-A

SUMMARY COMPARISON OF POTENTIAL IMPACTS OF
PROPOSED ACTION AND ALTERNATIVES

| <u>Impact Category</u> | <u>Proposed Action</u> | <u>No Action</u> | <u>Pond B-5/C-2 Collection</u> |
|--|-----------------------------|------------------|---|
| ENVIRONMENTAL IMPACTS | | | |
| Excavation | Point Source Collection | None | None |
| | Pipe Trenching | None | None |
| | Sump Installation | None | Treatment Facility |
| Topographical Deformation (permanent) | Treatment Facility | None | |
| Endangerment Species Impact | None | None | None |
| Wetlands Impact | 1,000 ft of linear wetlands | None | None |
| CULTURAL IMPACTS | | | |
| Resources | Negligible | Negligible | Negligible |
| Archaeological Impacts | None | None | None |
| Transportation | Limited | None | Limited - short term Greater - long term |
| LONG-TERM CONSIDERATIONS | | | |
| Remedial Action Period (Institutional Control) | TBD | > 30 yrs | TBD |
| VOC Contaminant Removal | Yes | No | Partially |
| Inorganic Contaminant Removal | Yes | No | Partially |

TABLE 8-1-B

SUMMARY COMPARISON OF POTENTIAL IMPACTS OF
PROPOSED ACTION AND ALTERNATIVES

| Impact Category | Proposed Action <div>Advanced Membrane Treatment</div> | Alternatives | |
|---|---|---------------------|-------------------------------------|
| | | No Action | Contact Filtration/ Ion Exchange |
| ENVIRONMENTAL IMPACTS | | | |
| Excavation | None | None | None |
| Topographical Deformation (Permanent) | Treatment Facility | None | Treatment Facility |
| Endangered Species | None | None | None |
| Wetlands | None | None | None |
| Cultural Impacts | None | None | None |
| Archaeological Impacts | None | None | None |
| Transportation | Limited | None | Limited |
| LONG-TERM CONSIDERATIONS | | | |
| Remedial Action Period (Institutional Control) | TBD | > 30 yrs | + BD |
| VOC Contaminant Removal | No | No | Limited |
| Radionuclide Removal | Yes | No | Possibly, but unproven |
| Inorganic Contaminant Removal | Yes | No | Yes |
| EXPOSURE OF GENERAL PUBLIC | | | |
| Construction | None | None | None |
| Routine | None | Future Release Risk | None |
| Accident | None | None | None |

TABLE 8-1-C

SUMMARY COMPARISON OF POTENTIAL IMPACTS OF
PROPOSED ACTION AND ALTERNATIVES

| Impact Category | Proposed Action | Alternatives |
|--|--------------------|---------------------|
| ENVIRONMENTAL IMPACTS | | |
| Excavation | Carbon Columns | No Action |
| Topographical Deformation (permanent) | None | None |
| Endangerment Species Impact | Treatment Facility | Treatment Facility |
| Wetlands Impact | None | None |
| Cultural Impacts | None | None |
| Archaeological Impacts | None | None |
| Transportation | Limited | Limited |
| LONG-TERM CONSIDERATIONS | | |
| Remedial Action Period (Institutional Control) | TBD | > 30 yrs |
| VOC Contaminant Removal | Yes | No |
| Radionuclide Removal | No | No |
| Inorganic Contaminant Removal | No | No |
| EXPOSURE OF GENRAL PUBLIC | | |
| Construction | None | None |
| Routine | None | Future Release Risk |
| Accident | None | None |

SECTION 9.0

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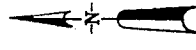
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DRAFT

EXPLANATION

- SOLID WASTE MANAGEMENT UNIT (SWMU) AND SWMU DESIGNATION
- LOCATION OF BARRELS DETERMINED BY VISUAL INSPECTION OR MAGNETOMETER SURVEY
- REMEDIAL INVESTIGATION AREAS



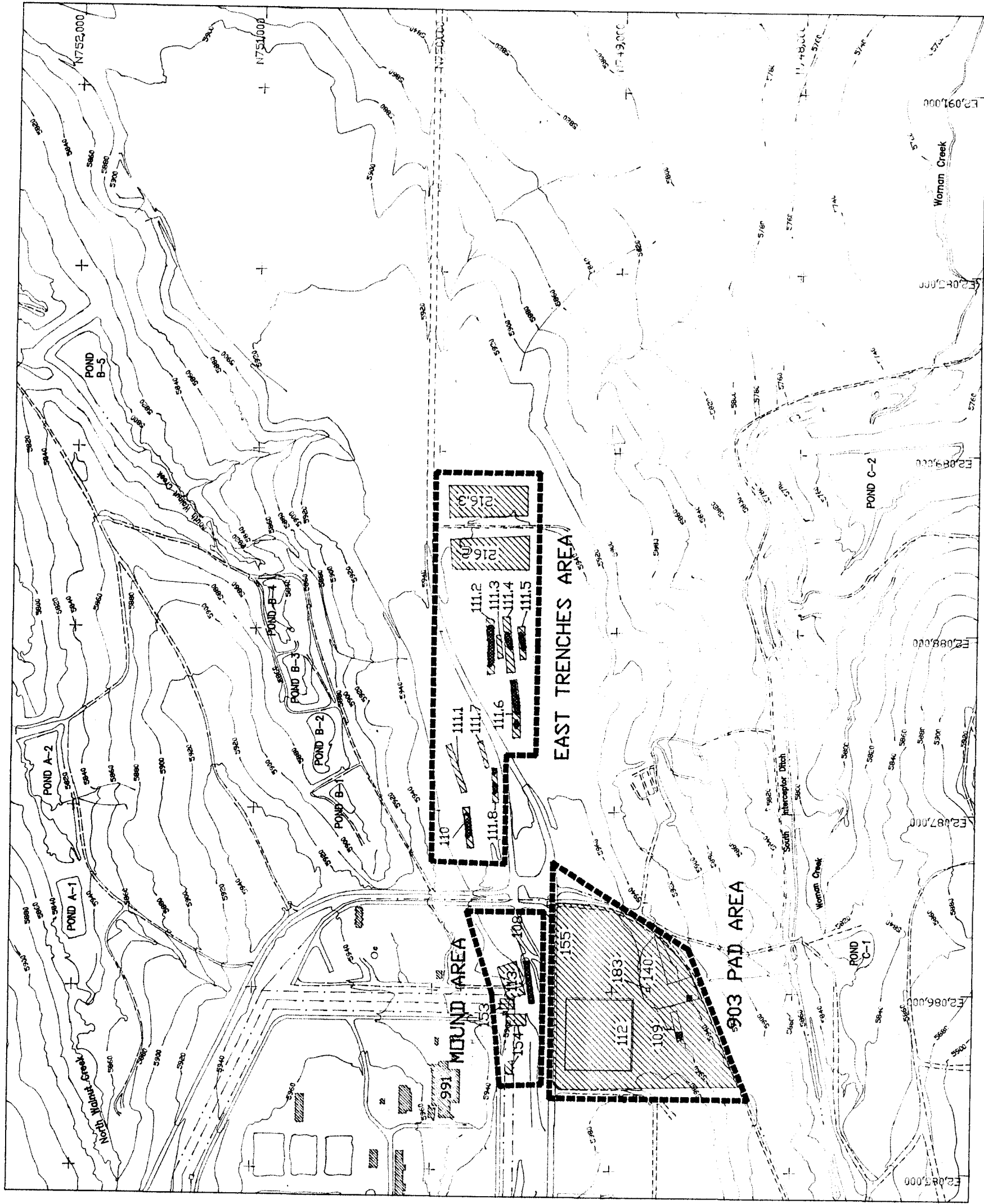
Scale: 1" = 600'
0' 300' 600'
CONTOUR INTERVAL = 20'

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

OPERABLE UNIT 2
SURFACE WATER IM/IRA

FIGURE 2-2
REMEDIAL INVESTIGATION AREAS
AND SOLID WASTE
MANAGEMENT UNITS

June 1990



EXPLANATION

SOLID WASTE MANAGEMENT UNIT (SWMU)

POTENTIOMETRIC SURFACE
ELEVATION (feet above
mean sea level)

ALL DATA BASED ON MEASUREMENTS
MADE APRIL 4-8, 1988 INCLUSIVE

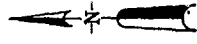
LINE OF EQUAL POTENTIOMETRIC
SURFACE ELEVATION (feet
above mean sea level)-DASHED
WHERE APPROXIMATELY LOCATED

NO DATA

BEDROCK MONITOR WELL

ALLUVIAL MONITOR WELL

PRE-1986 MONITOR WELL



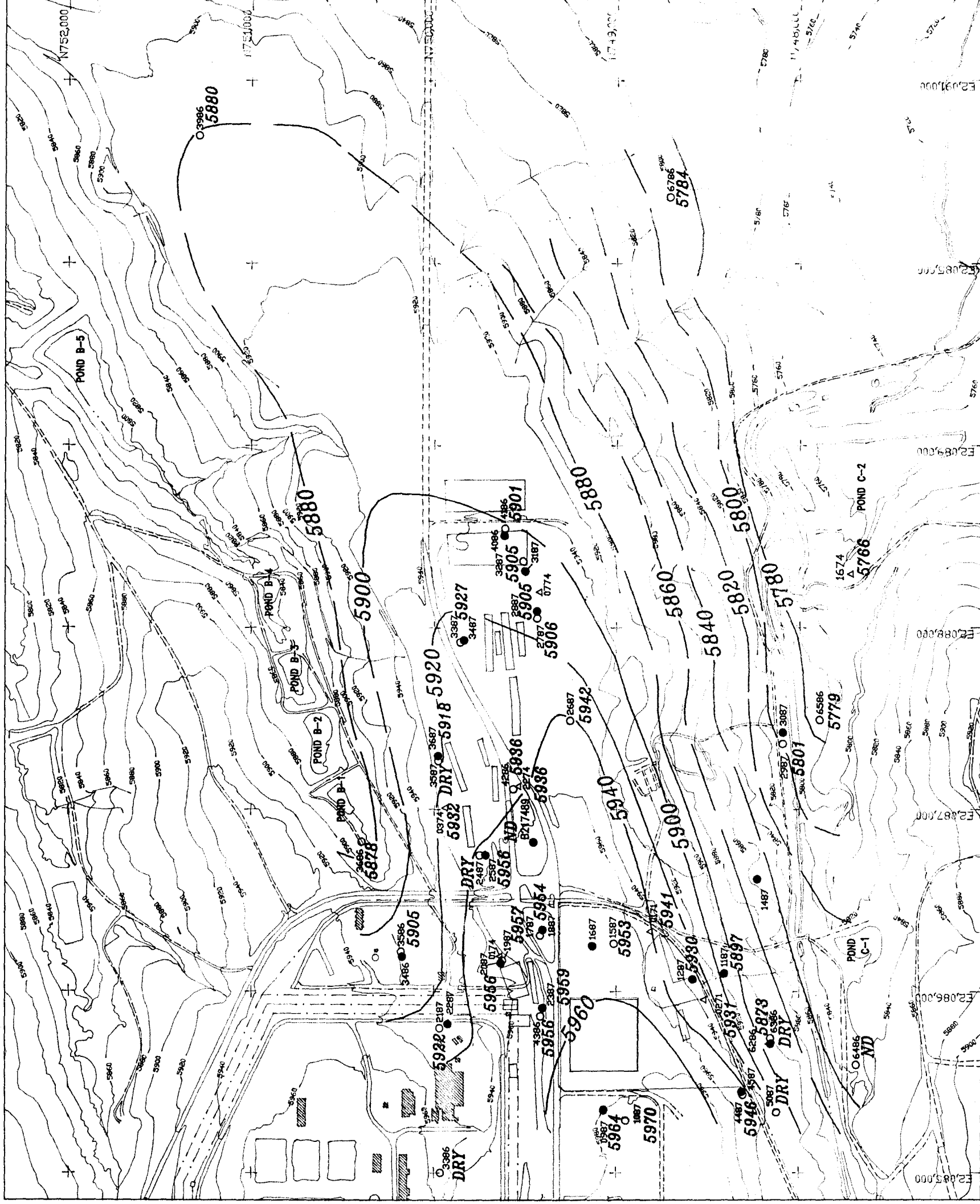
Scale: 1" = 600'
0' 300' 600'
CONTOUR INTERVAL = 20'

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado
OPERABLE UNIT 2
SURFACE WATER IM/IRA

FIGURE 2-5

POTENTIOMETRIC SURFACE OF
UNCONFINED GROUND-WATER
FLOW SYSTEM

June, 1990



EXPLANATION



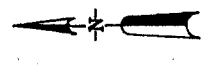
SOLID WASTE MANAGEMENT UNIT (SWMU)

500

LINE OF EQUAL CCl_4 CONCENTRATION ($\mu g/l$)
DASHED WHERE APPROXIMATELY LOCATED

NOTE: DATA VALUES SHOWN ON TABLE 2-1

- B217489 BEDROCK MONITOR WELL
- B213789 ALLUVIAL MONITOR WELL
- △ 0382 PRE-1986 MONITOR WELL



Scale: 1" = 600'
0' 300' 600'
CONTOUR INTERVAL = 20'

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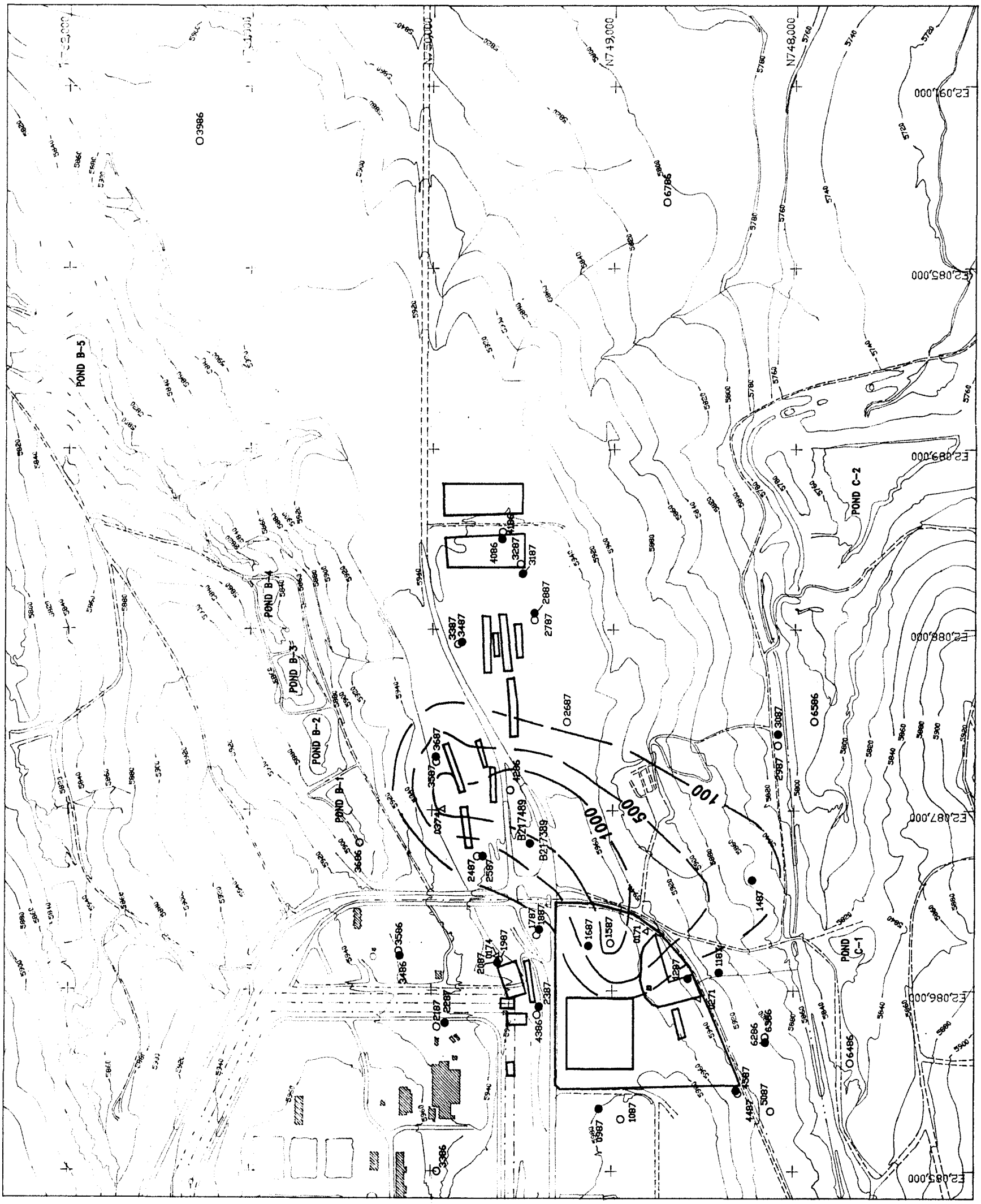
OPERABLE UNIT 2
SURFACE WATER IM/IRA

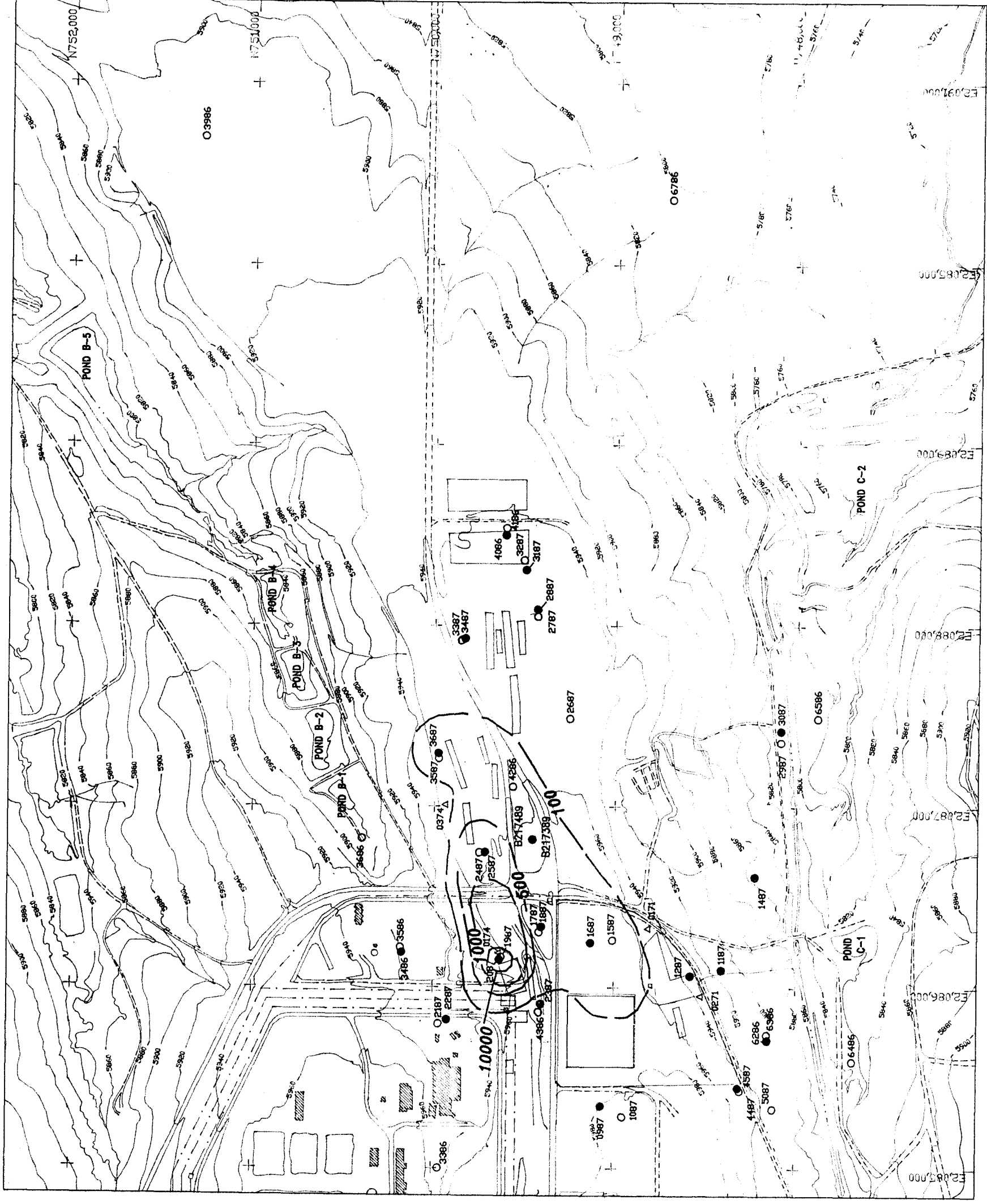
FIGURE 2-6

CARBON TETRACHLORIDE ISOPLETHS
FOR THE UNCONFINED GROUND-WATER
FLOW SYSTEM

Second Quarter 1989

June, 1990





EXPLANATION



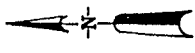
SOLID WASTE MANAGEMENT UNIT (SWMU)
AND SWMU DESIGNATION

500

LINE OF EQUAL PCE CONCENTRATION ($\mu\text{g/l}$)
DASHED WHERE APPROXIMATELY LOCATED

NOTE: DATA VALUES SHOWN ON TABLE 2-1

- B217489 ● BEDROCK MONITOR WELL
- B213789 ○ ALLUVIAL MONITOR WELL
- O382 △ PRE-1986 MONITOR WELL



Scale: 1" = 600'
0' 300' 600'
CONTOUR INTERVAL = 20'

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

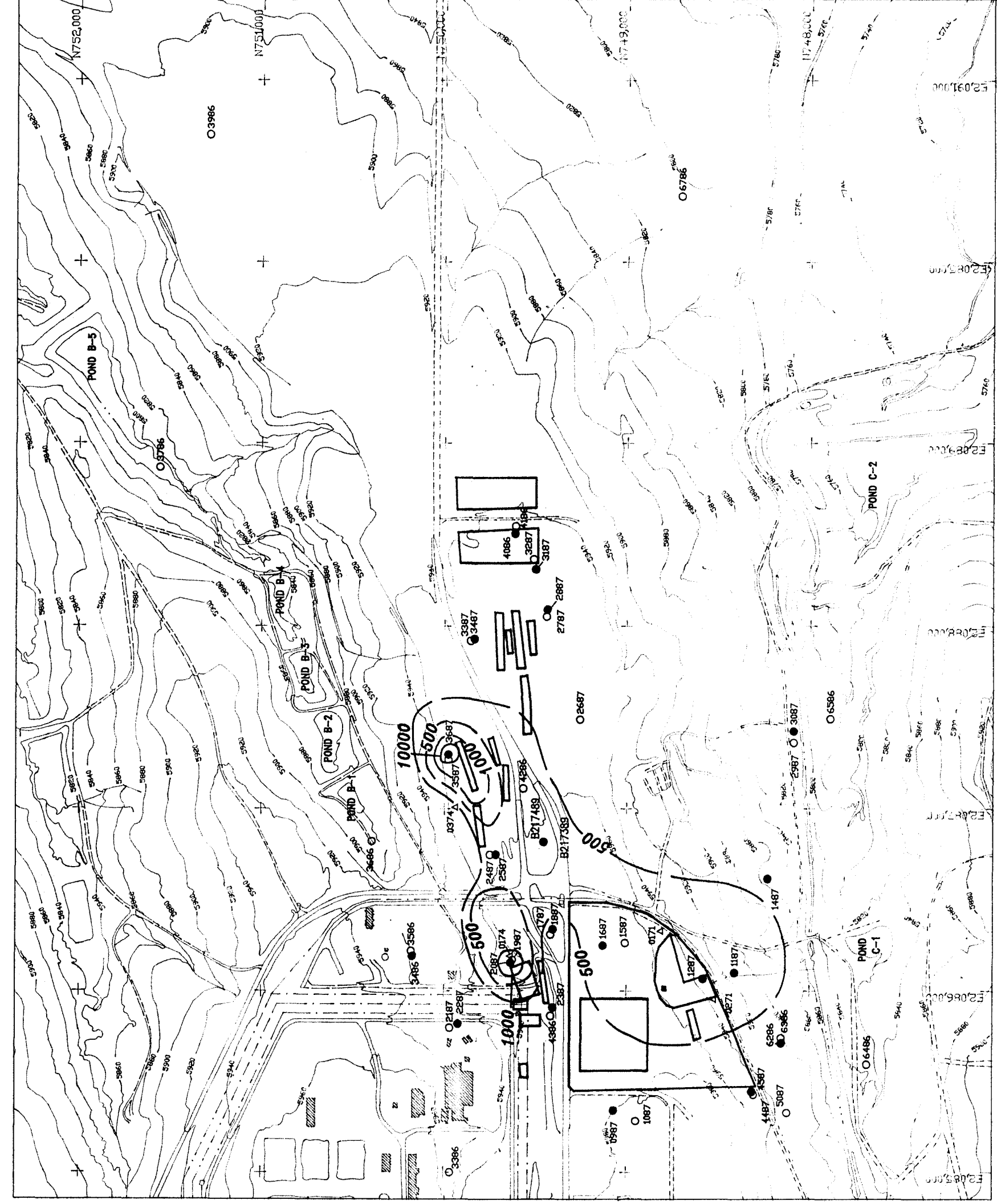
OPERABLE UNIT 2
SURFACE WATER IM/IRA

FIGURE 2-7

TETRACHLOROETHENE ISOPLETHS
FOR THE UNCONFINED GROUND-WATER
FLOW SYSTEM

Second Quarter 1989

June, 1990



EXPLANATION



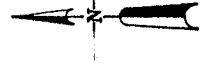
SOLID WASTE MANAGEMENT UNIT (SWMU)

500

LINE OF EQUAL TCE CONCENTRATION (µg/l)
DASHED WHERE APPROXIMATELY LOCATED

NOTE: DATA VALUES SHOWN ON TABLE 2-1

- BEDROCK MONITOR WELL
B217489
- ALLUVIAL MONITOR WELL
B213789
- △ PRE-1986 MONITOR WELL
O382



Scale: 1" = 600'
0' 300' 600'
CONTOUR INTERVAL = 20'

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

OPERABLE UNIT 2
SURFACE WATER IM/IRA

FIGURE 2-8

TRICHLOROETHENE ISOPLETHS
FOR THE UNCONFINED GROUND-WATER
FLOW SYSTEM

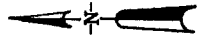
Second Quarter 1989

June, 1990

EXPLANATION

● SW-102
SURFACE WATER MONITORING STATION

△ SED-11
SEDIMENT SAMPLING STATION



Scale: 1" = 600'
0' 300' 600'
CONTOUR INTERVAL = 20'

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado
OPERABLE UNIT 2
SURFACE WATER IM/IRA

FIGURE 2-9

SURFACE WATER AND SEDIMENT
MONITORING STATIONS

June, 1990

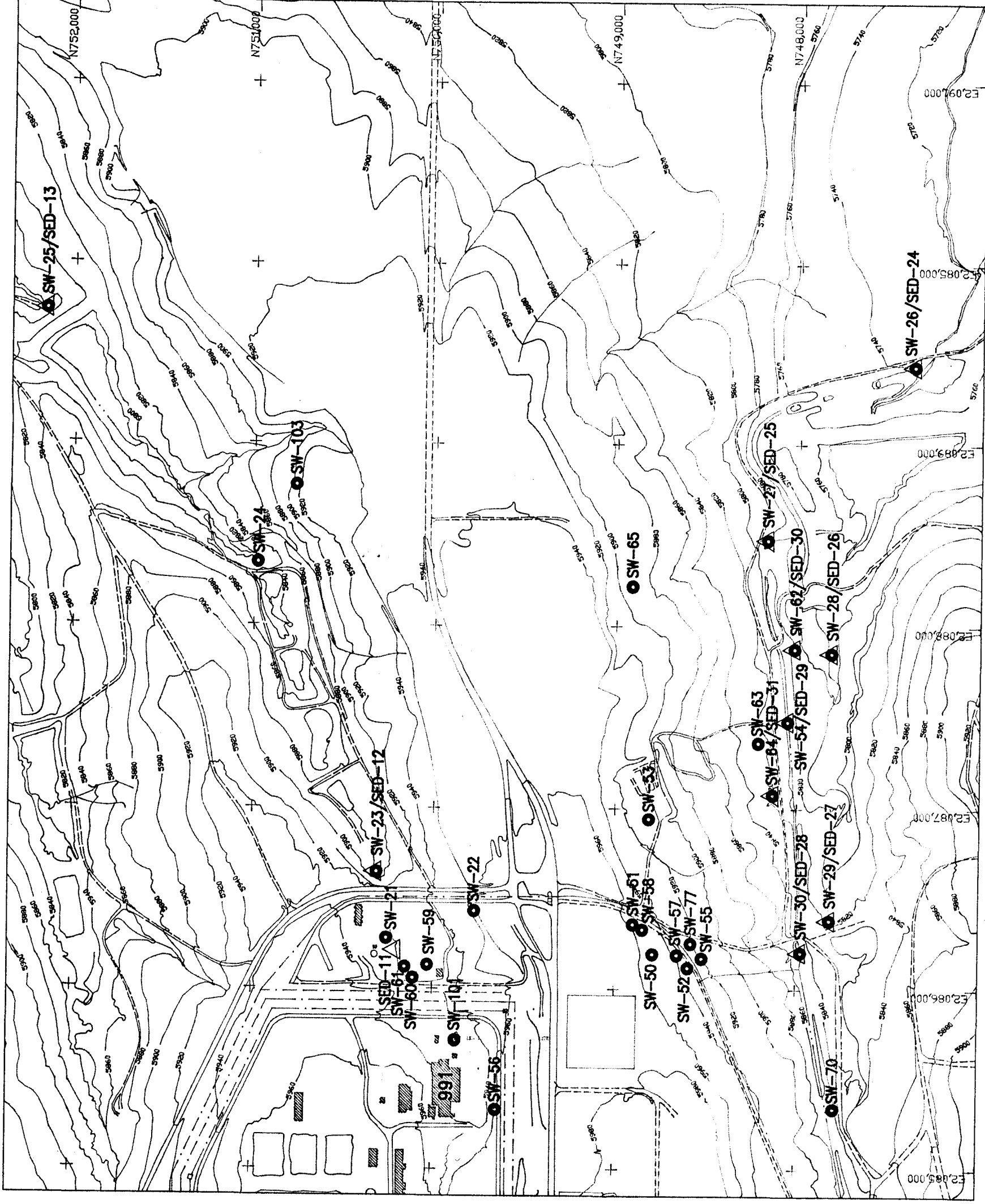


TABLE 3-3 (cont)

ROCKY FLATS PLANT

SURFACE WATER CONSTITUENTS: ABOVE POTENTIAL ARAR

| ANALYTE | POTENTIAL ARAR | 1 | | 2 | | SW053 (Flow = 0.5 GPM) | | UPPER SOUTH WALNUT CREEK (Flow = 38 GPM) | | SW063 (Flow = .5 GPM) | | SW064 (Flow = 0.5 GPM) | | SW103 (Flow = 15 GPM) | | FLOW WEIGHTED AVERAGE CONCENTRATION | FLOW WEIGHTED MAXIMUM CONCENTRATION |
|--|-------------------|---------|---------|---------|---------|---------------------------|---------|---|----------|--------------------------|---------|---------------------------|---------|--------------------------|-------|---|---|
| | | C avg | C max | C avg | C max | C avg | C max | C avg | C max | C avg | C max | C avg | C max | C avg | C max | | |
| Total Radionuclides (Concentration Units = pCi/L) | | | | | | | | | | | | | | | | | |
| Gross Alpha | 11.00 | 87.000 | 259.000 | 125.000 | 230.000 | 51.000 | 310.000 | 34.000 | 34.000 | 26.000 | 53.000 | 46.600 | 227.392 | | | | |
| Gross Beta | 19.00 | 28.000 | 63.000 | 7.800 | 14.000 | 44.000 | 340.000 | 93.000 | 93.000 | 28.000 | 55.000 | 42.607 | 238.017 | | | | |
| Plutonium 239, 240 | 0.05 | 17.000 | 60.000 | 20.000 | 56.000 | 0.310 | 3.100 | 0.242 | 0.242 | 0.005 | 1.400 | 1.461 | 6.245 | | | | |
| Americium 241 | 0.05 | 0.110 | 1.100 | 9.500 | 28.000 | 0.078 | 0.440 | 0.005 | 0.010 | 0.140 | 0.330 | 0.166 | 0.648 | | | | |
| Tritium | 500.00 | 230.000 | 829.000 | 222.000 | 310.000 | 222.000 | 500.000 | 1100.000 | 1100.000 | 200.000 | 458.000 | 232.900 | 497.158 | | | | |
| Total Uranium | 10.00 | 4.500 | 18.100 | 5.200 | 8.470 | 6.000 | 16.600 | 20.500 | 20.500 | 13.000 | 3.900 | 6.097 | 15.168 | | | | |

| | | | | | | | | | | | | | | | | | |
|--|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|--|
| Total Inorganics (Concentration Units = mg/L) | | | | | | | | | | | | | | | | | |
| Total Dissolved Solids | 400 | 479 | 790 | 534 | 666 | 385 | 682 | 663 | 675 | 694 | 720 | 406 | 490 | 422 | 649 | | |

1 The 903 Pad and Lip area contains surface water stations SW050, SW051, SW052, SW055, SW057, SW058 AND SW077.

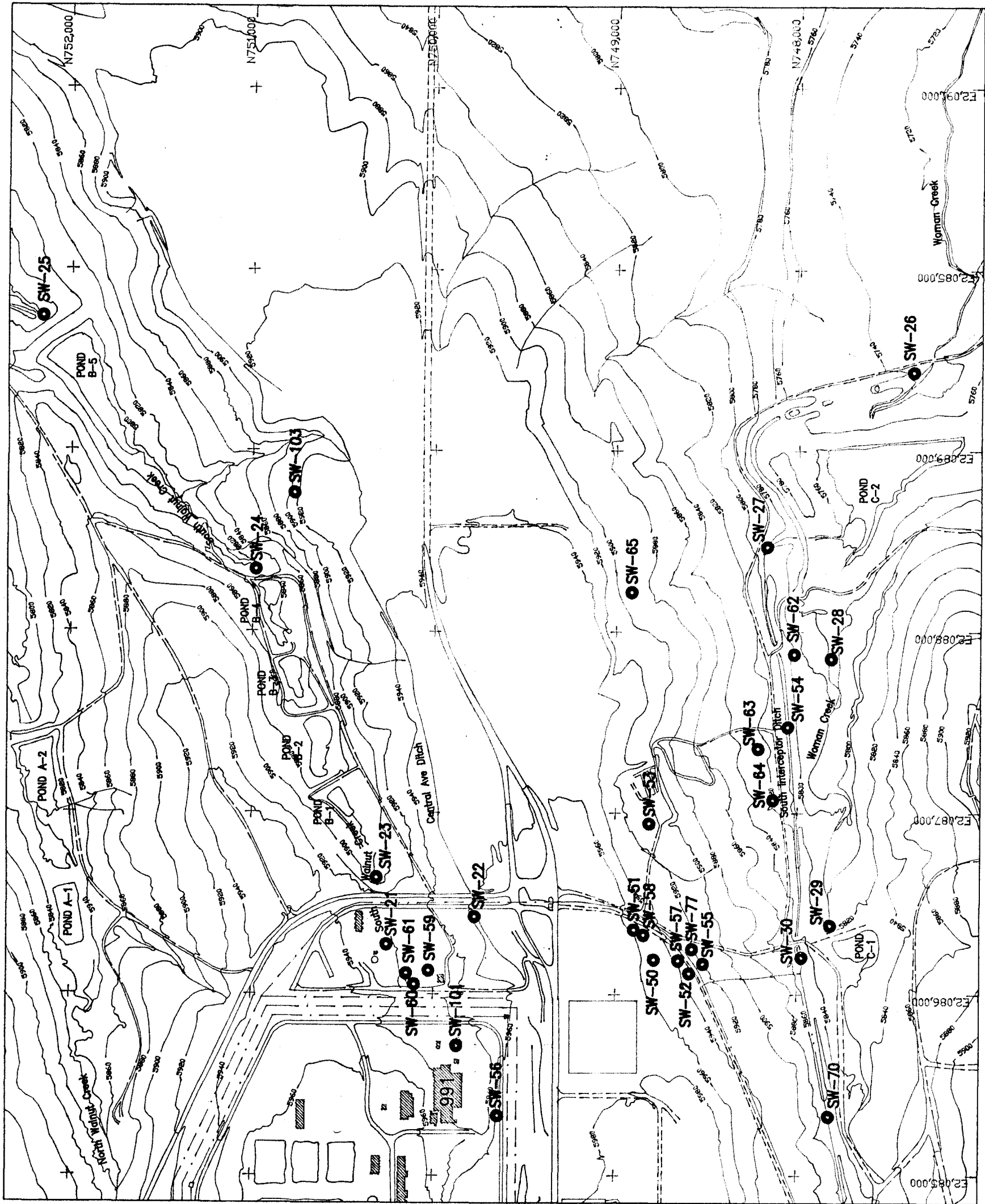
2 Upper South Walnut Creek contains surface water stations SW056, SW059, SW060, SW061 AND SW101.

3 C avg = Average Analyte Concentration

4 C max = Maximum Analyte Concentration

Table 3-3
ROCKY FLATS PLANT
SURFACE WATER CONSTITUENTS: ABOVE POTENTIAL ARAR

| | | 1 | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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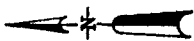
EXPLANATION

SURFACE WATER MONITORING STATION

IM/IRA SURFACE WATER
MONITORING STATION

SW-102

SW-59



Scale: 1" = 600'

A vertical scale bar with markings at 0°, 300°, and 600°.

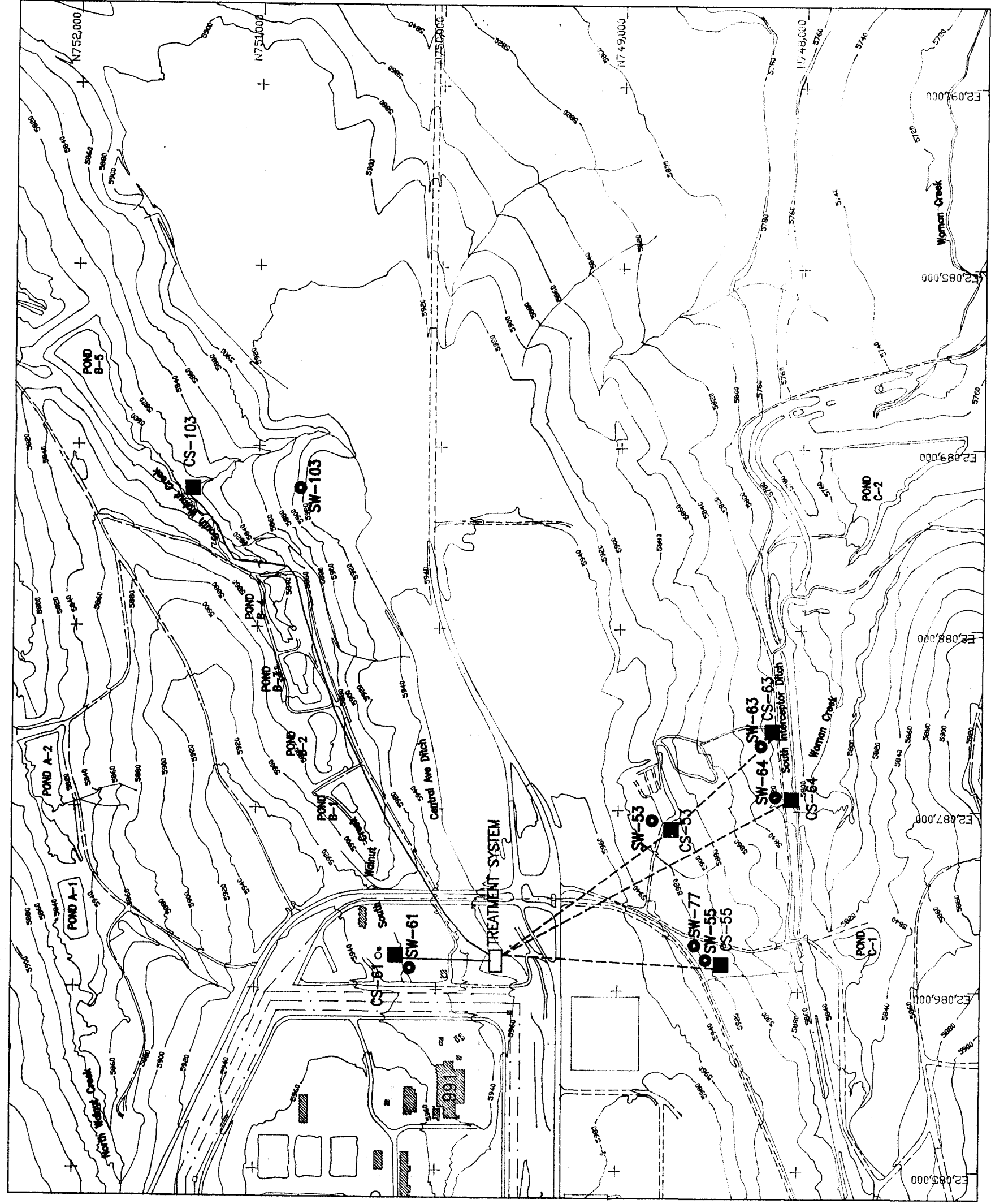
CONTOUR INTERVAL = 20'

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

OPERABLE UNIT 2
SURFACE WATER IM/IRA

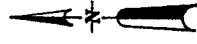
FIGURE 4-1

SURFACE WATER MONITORING STATIONS



EXPLANATION

- SW-103 SURFACE WATER MONITORING STATION
- CS-61 SURFACE WATER DIVERSION AND COLLECTION SYSTEM
- SURFACE WATER TRANSPORT TO TREATMENT SYSTEM BY TANKER TRUCK
- SURFACE WATER TRANSPORT TO TREATMENT SYSTEM BY PIPELINE



Scale: 1" = 600'
 0' 300' 600'
 CONTOUR INTERVAL = 20'

U.S. DEPARTMENT OF ENERGY
 Rocky Flats Plant
 Golden, Colorado

OPERABLE UNIT NO. 2
 SURFACE WATER IM/IRA

FIGURE 4-2

LOCATION OF SURFACE WATER
 COLLECTION AND TREATMENT FACILITIES

June 1990

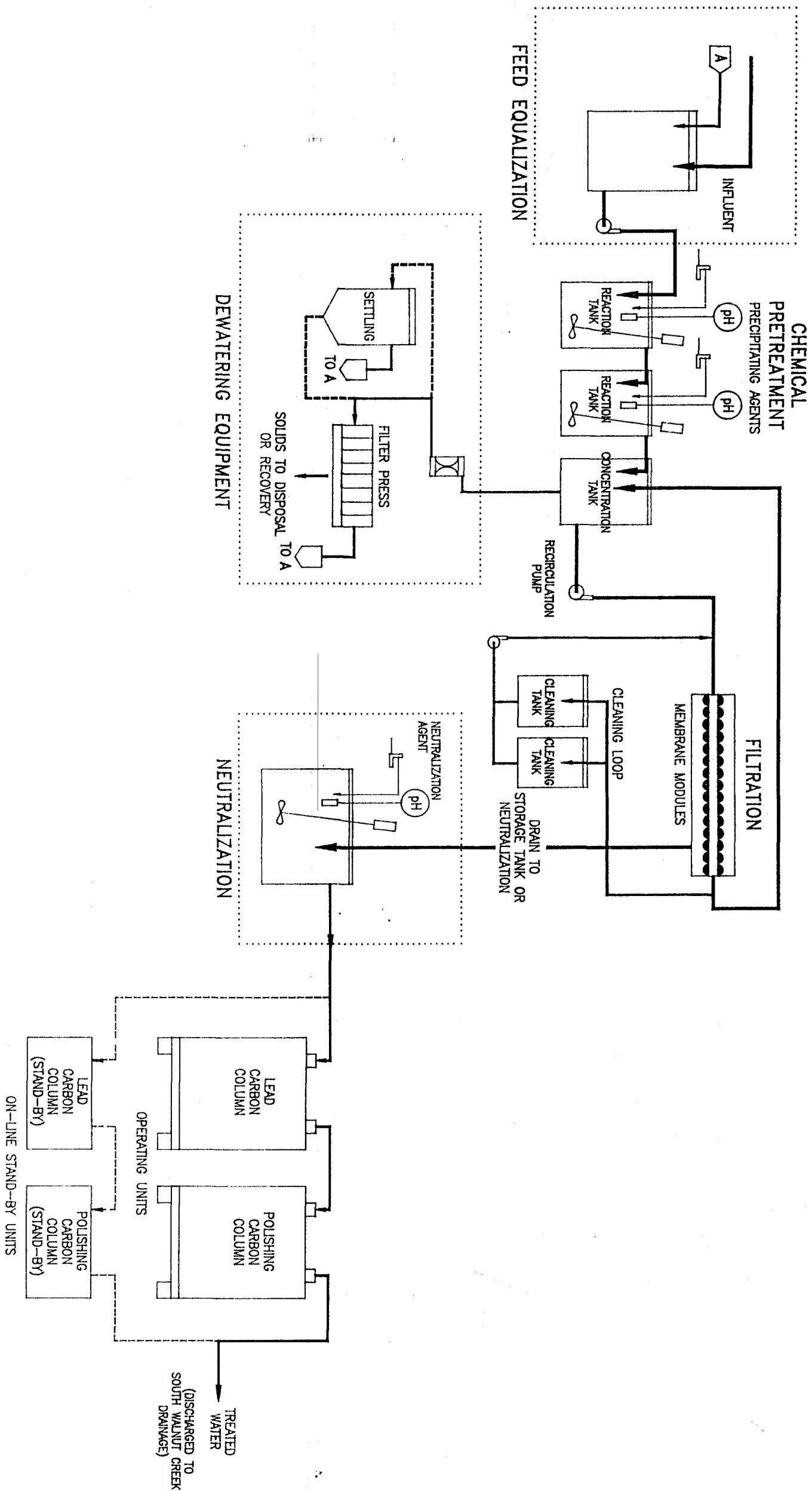


FIGURE 6-1
TREATMENT SYSTEM
PROCESS FLOW DIAGRAM